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New Ice Plant for St. Louis

POLAR WAVE ICE & FUEL CO. BUILD MOTOR DRIVEN PLANT FOR MAKING RAW WATER ICE

FOLLOWING THE DEVELOPMENT of the raw water system of making artificial ice, many new plants are motor driven. In St. Louis, Mo., the Polar Wave Ice & Fuel Co. has just put into operation its first motor driven, raw water ice plant, which is known as its Maplewood Station, and has a rated capacity of 120 tons in 24 hr. The water for the ice is taken from the city mains, which are supplied with Mississippi river water after it has been thoroughly treated in the city's filtration plant. Power for operating the machinery comes from the Keokuk plant.

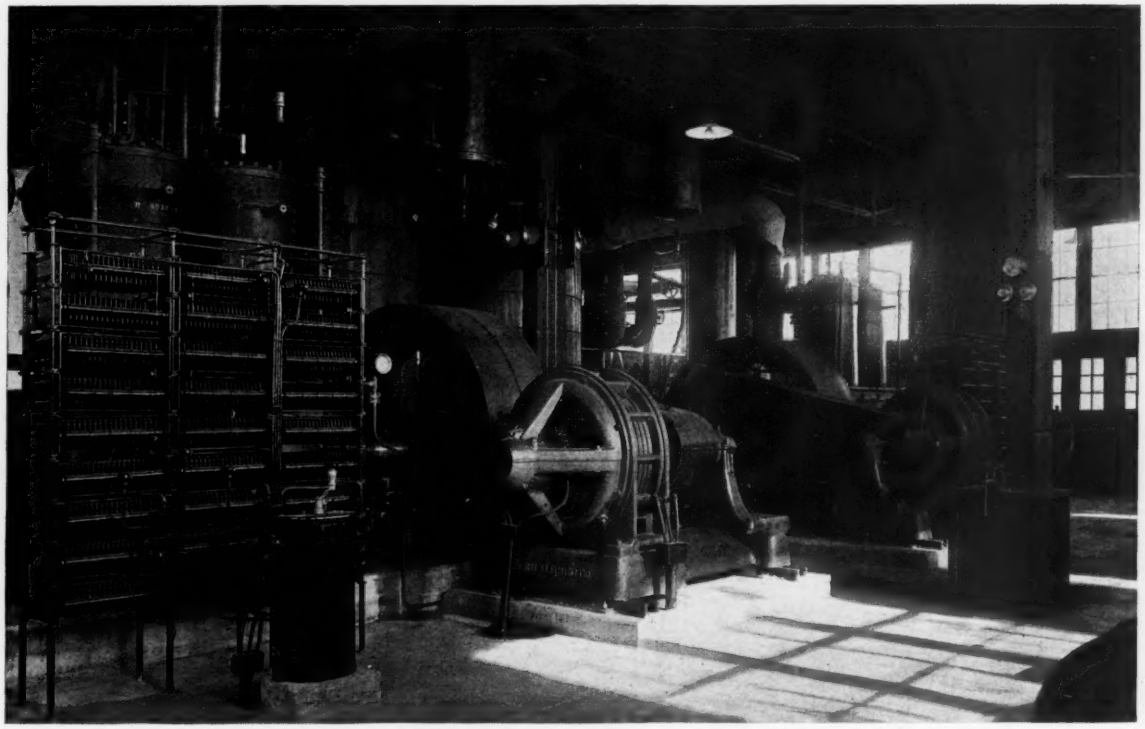


FIG. 1. AMMONIA COMPRESSORS IN MAPLEWOOD STATION

Two ammonia compressors are installed, each 16 by 18 in., run at 105 r.p.m., and rated at 60 tons. These are York vertical, two-cylinder type compressors driven by 200-hp. General Electric Co., three-phase, 25-cycle, variable speed, induction motors. The motors are designed to run indefinitely at 25 to 50 per cent reduction in speed and at 75 per cent reduction for a limited length of time. The compressors are driven by 16-in. Link-Belt silent chains, which give the compactness of direct connected units, but permit the use of motors of smaller dimensions.

After passing through an oil separator, the ammonia gas is delivered to an ammonia condenser located on

the roof of the ice storage rooms at the other end of the building. The condenser is of the Block atmospheric type consisting of 15 stands. The liquid ammonia drains to two receivers, each 36 in. in diameter by 18 ft. high, located in the compressor room.

In the freezing tanks, the ammonia coils are 10 pipes high, each divided into two sections with feed at the bottom of each section, thus giving two inlets and two outlets to each coil. The pipes are connected at the ends by hairpin bends which have 4-in. radii. In the York flooded system used for the cooling of the brine, four accumulators are employed, the suction pressure being between 20 and 25 lb. and the head pressure 120 to 185 lb., depending upon the load and temperature conditions.

From Water to Ice

Water for ice making passes through three York pressure filters in series; one of these is filled with quartz, the other two charcoal, all arranged for cleaning by reversing the flow of water through them. The water thus filtered goes to two storage tanks or precoolers from which it flows by gravity pressure to the ice cans.

Brine circulation is effected by four agitators in each of the two tanks; these are of the vertical type driven by 3-hp. G.E. motors. There is also one core water pump for each tank. The tanks are 34 ft. 6 in. wide by 90 ft. long and each has space for 1008 cans.

Among the conveniences in the ice room are the combination core drawing and filling devices by means of which the core water is first drawn, then, without removal of the pipe, a single valve is turned and the core is filled ready for the final freezing. The core water is delivered to the cooling systems. Drawing the ice is done with two ½-ton electric traveling hoists, one over each tank.

Air Agitation System

An interesting feature of the plant is the air agitation system. For compressing the air, two 12 by 12-in. air compressors, made by the Curtis Pneumatic Machinery Co., are employed. These run at 150 r.p.m. and have a rating of 300 cu. ft. per min. The driving power is a 35-hp. G.E. motor run at 1500 r.p.m. and connected to the compressor by a short belt with idler pulley. The compressed air is delivered to a receiver, the dimensions of which are 54 in. by 18 ft. It then passes through a precooler of the double-pipe counterflow type consisting of 3 and 2-in. pipe made up into two stands, 12 pipes high, and 18 ft. long. From the precooler the air, which is at 30 lb. pressure, passes through a Mason reducing valve and leaves the dehydrators at 18 lb. pressure. The dehydrators, of which there are two, are used alternately to cool the air to the point where it will give up its moisture and thus provide cold dry air for agitating the water in the cans. The object of dehydrating is principally to prevent the stoppage of the pipes in the ice cans. Cooling the dehydrators is done with brine circulated through coils; when those in one dehydrator become coated with ice the air is passed through the other, while the ice is being melted

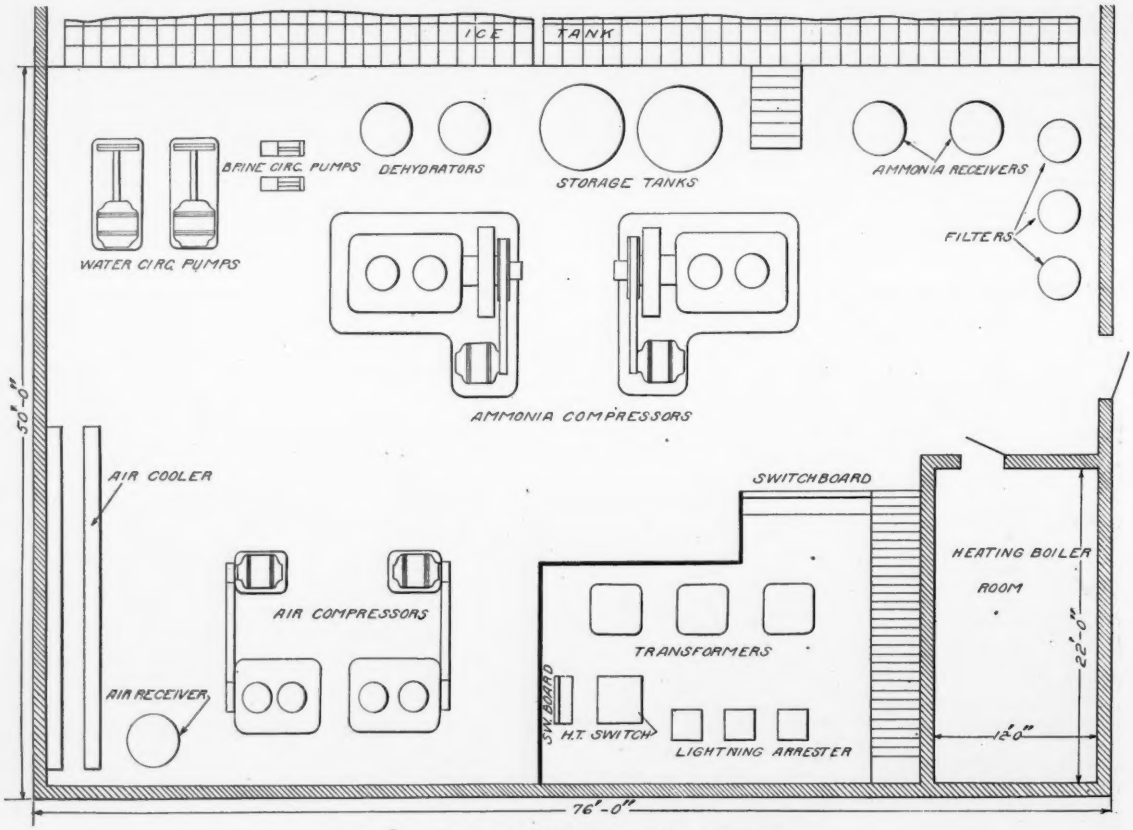


FIG. 3. PLAN OF MACHINERY ARRANGEMENT

and removed from the first. Brine is taken from the freezing tanks and circulated by means of two small centrifugal pumps.

Air for agitation is conducted in a network of pipes in the frame work of the freezing tanks; for each can an outlet for hose attachment is provided. Ice cans are made with a small tube running down one side and across to the center of the bottom of the can; this tube is connected by hose to the air pipe outlet.

FIG. 2. AIR COMPRESSOR AND AIR COOLER

Cooling Water System

Cooling water for the ammonia condensers is taken originally from the city mains, but city water is used only to make up losses due to evaporation in the regular operation of the plant. Two Hayton centrifugal pumps rated at 1700 gal. per min. circulate the water over the condensing coils. They work against a 40-ft. head at 1445 r.p.m. direct connected to 25-hp. G.E. motors. As previously stated, the condensers are located on the roof of the storage rooms, which is the highest part of the building.

After the cooling water has passed over the coils it flows by gravity to a system of spray nozzles consisting of 45, 2-in. sprays made by the Spray Engineering Co., the system being designed to care for 1500 to 1700 gal. per min. under a pressure of 6 to 7 lb. on the sprays. The spray pond is located on the roof of the freezing room and drains to the suction of the circulating pump.

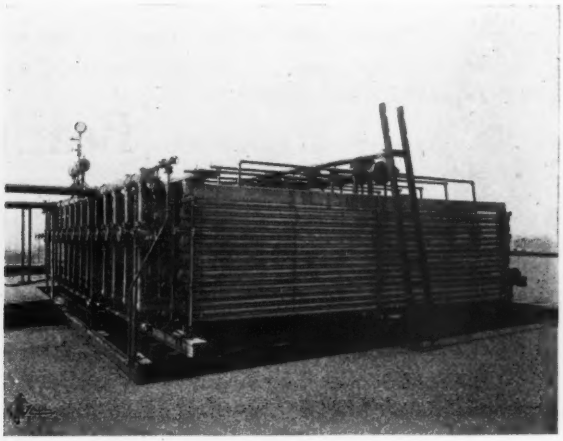


FIG. 4. VIEW OF AMMONIA CONDENSERS

One of the interesting features of the circulating water system is the piping. From the pumps to the level of the spray nozzles a 12-in. pipe is used; here it branches, a 10-in. pipe going up to the condensers and an 8-in. pipe to a mixing valve by means of which the water which has been heated by flowing over the condenser coils is mixed with water direct from the pumps. This mixing reduces the temperature considerably before the water reaches the sprays and has the effect of having a greater amount of water in circulation, but all the water is not pumped to the elevation of the condensers.

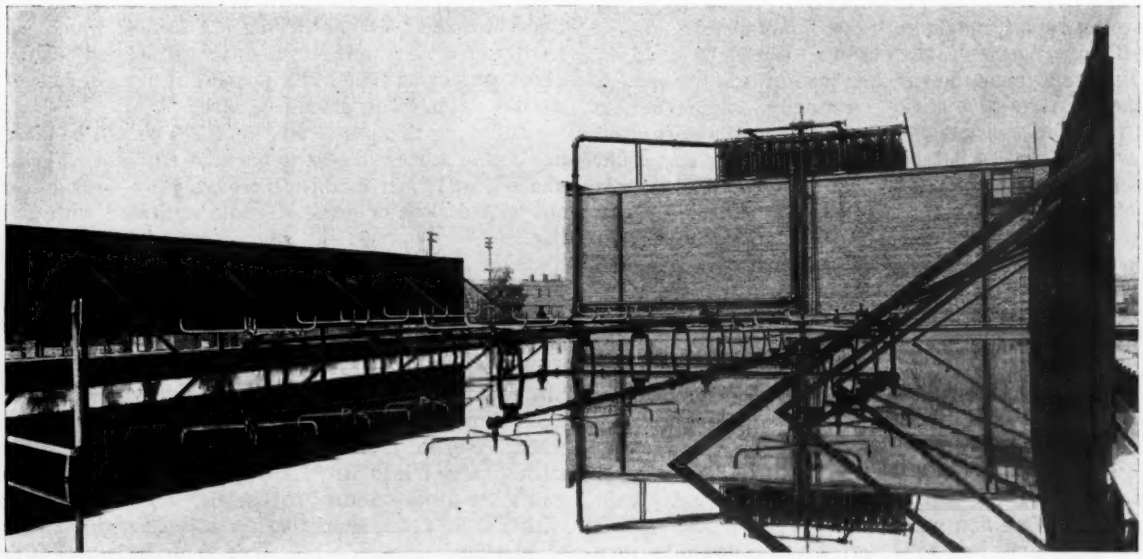


FIG. 5. SPRAY COOLING POND ON ROOF

From the freezing room the ice is delivered either to the shipping room or to storage. In the shipping room are two overhead coils made up of 1400 ft. of 2-in. pipe each; these carry the ammonia gas from the coils in the ice storage house to the suction of the compressors. There are three ice storage rooms, with a total capacity of 8000 tons; they are insulated with cork boards 4 in. thick, the floor having a layer of concrete to take the wear. The temperature maintained here is between 20 and 26 deg.

Substation Machinery

The electric substation for the plant consists of three 200-kw. G.E. self-cooled, single-phase transformers connected in delta which reduce the voltage from 13,200 to 440. These are protected by electrolytic lightning arresters and the high tension switches are operated by remote control. The station switchboard has six panels for the control of current distribution.

From this plant ice will be delivered in wagons to local customers, and railway facilities are provided for shipment in cars to out-of-town consumers.

Bearings---II

Preparing the Metal and Methods of Casting Employed

In preparing metals, the hardening element is first made by melting 4 parts copper, then gradually adding 12 parts tin, 8 parts antimony, and finally a further addition of 12 parts tin; this is made in a plumbago crucible such as is used for melting brass, and cast into ingots. When making up a batch of metal, this hardening element is added to the base.

To make up a batch of metal, melt the base in an iron pot, and then at a gentle heat, dissolve the hardening therein, using tallow or powdered sal ammoniac as a flux. If zinc forms the base, however, it should not be melted in an iron pot, but in a plumbago crucible, from which it may be poured and mixed with the other metals already melted in an iron pot.

The manner in which a babbit metal is applied is an essential factor in the results to be obtained; this, however, involves no difficulties whatever, as the directions for using babbit metals are exceedingly simple. There are 2 important rules to observe: First, have all in readiness and pour the metal as soon as it is hot enough to char a white pine stick. Originally, when this rule was made, it was thought that the metal was injured by overheating. It is true that superheating any metal does impair its vitality, but, as a matter of fact, it was only recently that it was discovered that if a white metal alloy was left in a highly fluid state for too long a time, the various ingredients of which it was composed would separate; the lead, being the heaviest, would gradually settle on the bottom and the tin and antimony would work to the top and a bearing formed in that condition would have soft spots (lead) and hard spots (antimony). As a babbit metal is a mechanical mixture, it is important that it should be poured in a homogeneous condition.

The next rule is to heat the box and mandrel. If a metal is poured into a cold box and around a cold mandrel, its free flow will be checked and a poor casting produced which, due to a soft backing, may be torn loose by the turning action of the shaft. Heating the mandrel also burns off any grease or moisture liable to be deposited upon it, and which if allowed to remain upon the mandrel would form into gas when covered by the hot metal, the gas thus formed holding back the metal and causing blow-holes in the face of the bearing. Many of the lower grades of bearing metals are liable to contain ingredients that produce blow-holes, no matter what precautions may be taken.

If possible, the metal should be peened before it cools appreciably, as a hot metal yields more readily to the blows of a hammer and if the utmost precautions are taken there is but little danger of cracking the metal. Any oxide or scum should be held back and not allowed to enter the box. The best time to check the heat is when the metal begins to change from a silvery to a yellowish tinge.

Rebabbiting Bearings

Bearings of machines require to be rebabbited only when, due to natural wear or accident, the shaft is allowed to ride lower than consistent with safe and proper operation. When this occurs, the shaft should be raised by means of a chain fall from above or blocking and jack screws from below and the various sections, or quarters of which the box is composed, removed. These are then cleaned of the old babbit, which may readily be done by placing each in an inclined position, heating a pot of babbit and pouring it over to melt out the old metal. This should be saved.

Following this procedure, the shells should be placed in a fire of moderate heat to burn off any and all grease and oil, and then cleaned thoroughly by wiping them out with a cloth or piece of waste saturated with gasoline.

Some engineers prefer to replace the shells and after permanently lining and leveling the shaft, pour the metal, first in the lower quarter, then the side pieces and then the cap. Others provide a form having a diameter somewhat less than that of the shaft, held in place with the shell by means of clamps, and after the mold thus formed is stood on end, the pouring is done when the metal is hot enough to char the end of a pine stick plunged into it. Each quarter is treated alike, and after all are poured the babbit is carefully peened with a 3 or 4-lb. hammer to make it firm, preparatory to placing it in the lathe. Do not strike a hard blow, but a succession of light ones, as this increases the density of the metal.

The quarters are then assembled for boring; the take-up wedge is placed in with them and the outside carefully calipered to insure a proper fit with the ways of the frame. When that is done and they are in a true circle, they are ready for boring, care being taken, however, to see that the quarters are plumb and are held securely together. When they are cut to a diam-

eter no greater than 1/32 in. larger than the shaft, no more metal should be removed.

Pouring the babbit with the shells in place is not to be recommended and should not be done unless circumstances render this absolutely necessary, as doing so has a tendency to spring the shaft and due to the chilling of the metal a poor cast is liable to result. The main bearings of small engines and the rocker shaft bearings of large engines in which no removable shells are provided can be cast only in this manner, although whenever possible a mandrel should be used. The shaft or mandrel should be carefully lined and level and provision made to prevent the molten metal running out while pouring.

For small jobs, stiff mud, fire clay or putty will do to stop up the openings; if these are quite large, wrap a rag or cloth around the box or bearing, over the putty. This will prevent leakage.

A good mixture to use when babbiting is easily made by taking old pipe coverings and pulverizing by pounding with a mallet or stick, and sifting to remove lumps, etc. Mix this with common cylinder oil to a stiff paste some little time before using, otherwise it will not stick well. This mixture may be used in the same way as is the clay or putty, and when not in use must be kept in an air-tight retainer; if, however, found to be too dry when wanted again, add a little more cylinder oil.

For large bearings it is necessary to provide some kind of stiff backing capable of withstanding the pressure due to the weight of the metal. A scheme which has met with considerable success consists of taking a wide board and cutting away a circular section so as to fit the shaft and with the top of the board above the metal line. A piece of paper placed between the board and the plumber block serves well as a gasket and prevents the hot metal from coming in contact with the board. After the lower shell has been cast, the side chucks may be poured, another form cut to fit the curvature of the shaft at this point being provided to avoid running of the metal. The cap is handled in a similar manner.

Have the forge and melting pot near at hand and be sure to make one pour by providing a pot of ample size, and have two ladles, so that while one man is pouring the other may be getting another ladle full. When the form is apparently full, add a trifle more metal in order that any impurities tending to remain after skimming will overflow. The babbit will shrink somewhat in cooling, and by continuing to pour a little after the form is cool, shrinkage in the bottom of the form, due to cooling, will be compensated for.

Do not be in a hurry to remove any kind of form or dam you employ, for if this is done too soon the babbit may fall out or at least be disturbed so as neither to machine well or prove durable.

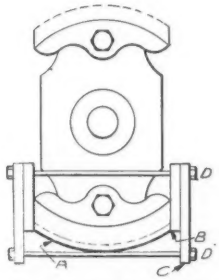
Bearings capable of being handled in a lathe should be turned at a moderately high speed with the first cuts comparatively coarse and the last or finishing cut fine. The final finish of any bearing, whether this be mold cast or cast around the shaft or a mandrel, should always be made by means of scrapers. It is only by doing so that a good fit may be obtained, especially if the shaft is badly worn.

Casting Crosshead Shoes

The method of casting crosshead shoes where the guides are of the bored type, depends somewhat upon the available facilities for doing the work. In Fig. 1 is shown a crosshead of the bored type as usually found in practice, the dotted lines indicating the wearing surface of the shoes; the upper shoe is shown cast, while the lower one is prepared for casting.

Preliminary procedures consist of removing the shoes from the crosshead and melting the babbit over a forge, if possible resting the shoe on a piece of sheet iron projecting over the edge to allow the molten babbit to flow to one side. Care must be exercised to prevent the casting becoming too hot. When sufficiently cool to handle, stand the shoe on end and place in position form A made of sheet iron and indicated by the black line. Have it project outside the dotted line about ¼ in.

Use two boards, B, in the position shown, and to hold all in place, use two or more pairs of clamps, C, which are about 2 by 4 in. and held together by ⅝-in. bolts, D, D. When certain all parts are in proper place so that when cast there will be an ample stock of babbit on the shoe after turning, bank up around the outside of the shoe and clamps with sand or clay, being careful there is no moisture present.



METHOD OF BUILDING UP FORM FOR POURING BABBIT

If this work is carried on with dispatch, the shoe will still be warm enough to insure a good pour. Then pour the babbit, following the general directions given relative to the casting of bearings, and after the castings have cooled and allow being handled, turn them over on a bench or the floor and peen the babbit well.

With a piece of small round iron or cold rolled steel, say ¼ in. in diameter, make a gage of the guides, taking the measurement at the ends of the slide where the wear is most prominent. The crosshead should be turned approximately 0.001 in. smaller per inch of diameter than the diameter of the guide. To secure this, after making the gage the exact size, file off one end until a 0.015-in. feeler may be inserted between the gage and the guide surface. Then set the calipers according to this gage.

If the crosshead and piston rod can be removed readily and a lathe of proper size is at hand, screw the piston rod into the crosshead from the front far enough to put on the jamb nut having the end of the rod flush with the nut. Then place the rod and crosshead in the lathe and insert the shoes; if they are of the wedge adjustment type, draw the wedge back as far as possible in order to provide for maximum adjustment. In many crossheads there is provision to insert a cap screw into a tapped hole on the inside of the shoe,

through a hole left in the crosshead casting for that purpose. The object of this is to hold the shoe up against the wedge during the process of turning.

If not possible to remove the reciprocating member, run the piston rod out full stroke, or nearly so, and by calipering from the rod to the top guide (making proper allowance for wear of rod) adjust the shoes until the rod is central in the guide. Then block the rod as near the crosshead as possible.

Remove the lower shoe, melt out the old babbit and replace and wedge it up against the crosshead by means of two small wedges of maple or brass. If wooden wedges are employed, they must later be removed when the space occupied by them can be filled in; if of brass, the wedges need not be taken out.

The lower slide should be coated with a light covering of oil, graphite or white lead, to prevent adhesion. If possible, heat the slide with a torch or hot bars to insure a good pour. Build a dam of black metal at either end of the shoe, backing it up with putty, clay or a paste, and also build an open dam along the sides in which to pour and which will also permit free egress of air. When babbiting the lower shoe of a horizontal unit, it is well to cut small channels from one anchor hole to the next, sidewise, to permit escape of air from the lower anchor holes and insure good contact.

The shoe must be drawn backward as far as possible when rebabbiting; after it is cooled, remove, trim off the edges and scrape so as to present a proper bearing surface.

After pouring the bottom shoe, disconnect the connecting rod and turn the crosshead halfway around, thus bringing the top shoe to the bottom where it may be babbited in a manner like that employed for the other shoe. Be sure, however, that the top shoe requires rebabbiting, as ordinarily there is little wear here, even though the engine runs under.

On vertical units, center the rod and crosshead, build a metal dam under the shoe and place metal strips at the sides, all substantially braced and supported. Fill all crevices with putty or other like material so as to prevent loss by leakage. Pour the metal following directions outlined above.

Babbiting Crosshead and Crankpin Boxes

As connecting-rod boxes are usually of brass construction, they may be tinned previously to rebabbiting by heating in a clean fire, and while hot using a flux of sal ammoniac with ordinary solder, so that the interior of the box may have a coating of solder to which the babbit will adhere by fusion as soon as poured.

If not possible to tin the brasses, provide anchor holes at least 3/8 in. in diameter for the smaller sizes, up to 5/8 in. for the larger ones, and proportionately deep. Then drill two or three smaller holes at angle in the bottom of each anchor hole so as to secure the anchor better.

Due to difficulties arising on account of the pin probably being out of round or scored, the location being such as to render it impossible to pour the metal properly or on account of inability to heat the pin to insure a good pour, it is seldom that a crankpin box can be babbited on the pin. Crosshead pin boxes cannot be babbited in place, so it is obviously best to babbit the boxes on a mandrel of cast iron and of such shape that when ready to use it will resemble part of the crank disk with the pin in place. A pattern for such a casting may readily be made and the casting with the necessary machine work will cost but a small amount. If the box is to be babbited without boring, make the mandrel the same size as the pin, and after relieving the box about 1 in. back from the joint, the bearing may be quickly made with a scraper. If, however, it is desired to bore the box, have the mandrel from 1/4 to 1/2 in. smaller than the pin and after taking off the roughing cuts, peen well; then give the finishing cut.

Having determined the manner in which the job is to be finished, place the boxes on the rod using the wedge to draw the box up to the shims which are placed between the halves for clearance and which should be not less than 1/8 in. or more than 5/16 in., depending upon the size of the box.

War and the Worker

By John Pierce

WE owe it to the nation and the flag that makes us free,
To help in the salvation of the lands beyond the sea;
And, if we're not selected to man the firing line,
We need not be dejected because we're left behind.

For all the hardest service won't be in sunny France.
Hard work and sacrifice at home will Freedom's cause advance.
The boys in blue and khaki will each one do his bit,
But progress' wheels cease turning should the engines slow or quit.

We, in the mighty struggle, who stay to man the shops,
Must keep the engines turning, that they slacken not, nor stop.
We've got to keep them turning through the night and through the day,
To keep Old Glory floating free; for she's uncased to stay.

The boys with wrench or shovel; the boys with sledge or hoe,
As well as those in khaki, will fight to keep her so.
Though some may have too many years, and others have too few
To cross the briny ocean and see the fighting through,
Yet each one left, remember, is a cog, a rod or cam
To help the mighty engine in the shop of Uncle Sam.

Unfilled car orders for freight cars were 70,380 on Oct. 1 as compared with 94,854 for Oct. 1, 1916, with no more equipment available than a year ago. Equipment is being more effectively used as is shown by the fact that in 1917 upwards of 15 per cent more service was rendered by the railroads than in 1916, with practically the same plant. This was accomplished by co-operation of roads with each other and co-operation of shippers with the roads. The need for this will be increasingly greater as demands for transportation increase due to government business.

Effect of Brick Arch on Smoke Abatement

PRINCIPLES UNDERLYING METHODS OF SECURING COMPLETE COMBUSTION

DURING the past 10 yr. a great amount of investigation work has been done on the problem of smoke abatement and it is generally conceded that if combustion is complete, the smoke problem is solved. To secure this condition, many devices have been employed and specially designed furnaces have been built. In this connection, readers of Power Plant Engineering will be interested in what J. T. Anthony said at the recent convention of the Smoke Prevention Association in discussing the effect of the brick arch on locomotive smoke abatement. Although furnaces for stationary boilers differ greatly from those on locomotives, it will readily be recognized that locomotive furnace design is the more difficult problem if equal results are to be secured. The principles offered by Mr. Anthony are sound and apply in any place where coal is burned. In the paragraphs which follow we quote freely from the paper presented.

While it is generally recognized that the properly installed brick arch will reduce the smoke emission from a locomotive, the reason therefor may not be clear. The formation of smoke is due primarily to the decomposition of the volatile hydrocarbons contained in all bituminous, semi-bituminous and lignitic coals; though the presence of coal-dust that is fed into the firebox and, being caught up by the draft, is whirled out through the flues unburned, adds to the smoke emissions.

As the name indicates, the volatile hydrocarbons are compounds of carbon and hydrogen, and are of a very complex character. The heavier compounds are driven off in the form of tar, in a semi-liquid or solid state; while the lighter hydrocarbons are driven off in a gaseous state. The distillation begins at a temperature around 400 deg. F., and is completed at a temperature of 1600 deg. F. The decomposition of the volatile matter by the action of heat takes place very readily at temperatures above 1400 deg. F.

The exact composition of the hydrocarbons when first distilled from the coal at the different temperatures is not known, as they break down so readily under the influence of heat and are so unstable that it is impossible to collect samples for analysis.

The indications are, however, that the heavy hydrocarbons when first driven off contain (by weight) about 85 per cent carbon, 10 per cent hydrogen, and 5 per cent oxygen. Under the influence of heat, these hydrocarbons break down into carbon, hydrogen, oxygen, lighter hydrocarbons of the methane (CH_4) series, and lighter unsaturated hydrocarbons.

The hydrogen, a colorless gas, is highly inflammable and burns readily if there is an oxygen supply above the fuel bed. The lighter hydrocarbons also burn readily, if the oxygen supply is sufficient. If it is insufficient, the hydrocarbon is broken down by the heat into carbon and hydrogen—the hydrogen either combining with the oxygen that may be present, to form water, or escaping into the flues unburned.

Carbon does not exist in a gaseous state at temperatures with which we are familiar in furnace practice; so that when the various hydrocarbons are decomposed, the carbon is precipitated as a solid particle in the form of soot; and these incandescent particles floating in the flame, give it the luminous color.

We are apt to think of this carbon as being set free and deposited in the form of atoms, but such is not the case. We have no knowledge of the atom existing as a unit, separate and distinct. The small particles of soot with which we have to deal are probably made up of a large number of carbon molecules. The very smallest soot particle that exists is this molecule, which consists of a number of carbon atoms (probably 12), held together by a sort of bond or attractive force of an electrical nature. As a result, the soot particles (which are the primary source of all smoke) have a very tenacious structure, and are extremely difficult to break down, when once formed.

In order to burn them completely, it is necessary to supply a number of oxygen molecules sufficient to combine with each carbon atom; to bring them into contact with the carbon atoms at a temperature high enough to sustain combustion; and to provide time sufficient for combustion to be completed.

These conditions are similar to those met with in burning the "fixed carbon" on the grate, but are more difficult to fulfill. A piece of coke, or carbon, burning on the grate is held more or less in place until it is consumed; and combustion is accelerated by the high temperature prevailing in the fuel bed and by the violent scrubbing action of the oxygen (in the air) rushing through the fuel bed.

The particles of soot (resulting from the breaking down of the hydrocarbons) are well on their way to the flues at the instant of their formation. As was noted above, they are not brought into violent mechanical contact with a supply of oxygen, but float along in an atmosphere that has been robbed of much of its oxygen, in passing through the fuel bed. The temperatures prevailing in the upper part of the firebox are sufficiently high, generally, to insure ignition and combustion; but under ordinary conditions, the time available for combustion varies from 1/5 to 1/10 sec., and this is insufficient.

The small quantity of oxygen above the fuel bed; the difficulty of bringing the oxygen in contact with the soot, due to ineffective mixing and the interference of the large volumes of inert and noncombustible gases; and the short time available for combustion, make the burning of soot and the elimination of smoke in locomotive operation a rather difficult matter.

It is easier to prevent the formation of soot (or smoke) than to burn it when once formed. The precipitation of soot can be prevented by having an excess of heated air (or oxygen) above the fuel bed, and bringing this heated oxygen in intimate contact with the volatile hydrocarbons at the instant they are distilled off.

Research work done by the United States Bureau of Mines indicates that the hydrocarbons are decomposed when they have traveled but a few inches from the

top of the fuel bed; and if the precipitation of carbon is to be prevented, the air (or oxygen) must be introduced at the top of the fuel bed and intimately mixed with the issuing hydrocarbons.

The chief function of the brick arch in abating smoke is that of a gas mixer. By baffling and compelling all of the gases to pass through a relatively restricted area above the arch, an intimate mixture of the volatile combustible with the oxygen is insured. While the mixing of the gases at the end of the arch does not take place soon enough to eliminate smoke entirely, it has the effect of reducing the smoke emissions, as shown by the tests quoted.

Figure 1 shows a firebox without an arch with a characteristic fire; that is, with a bank of green coal under the fire door; the fire gradually thinning down toward the front end of the grate, where the draft has possibly pulled a hole in it. Under such conditions, the bank of green coal under the door is expelling large volumes of rich hydrocarbons, which, passing up along

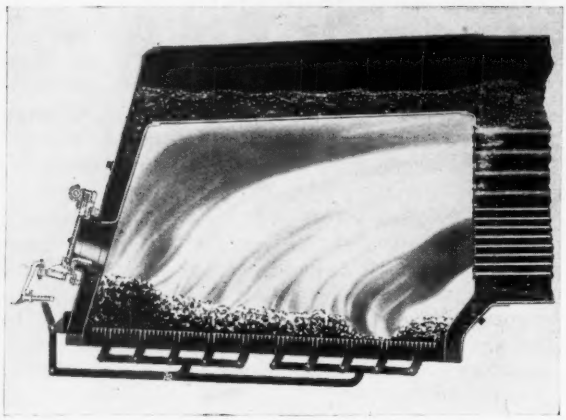


FIG. 1. FIREBOX WITHOUT ARCH

the top zone of the firebox, are decomposed by the heat, causing the formation of soot, which either escapes at the front end as smoke, or is deposited on the heating surfaces to retard the flow of heat. At the same time, a large excess of air is rushing through the thin portion of the fire on the front of the grate, and is passing directly into the lower flues; without in any way aiding the combustion of the hydrocarbons being distilled in the back of the box and, very often, causing flue leaks or failures.

Figure 2 illustrates the action of the arch under similar conditions. Here, any excess air coming through the thin portion of the fire on the front of the grates is heated up, deflected and forced back over the end of the arch, where it is mixed with the gaseous combustibles arising from the green coal under the door. With the ordinary type of firebox (as shown), the combustion chamber space and the flameway are insufficient to give all the particles of soot and combustible gas time to burn before reaching the flue sheet; but such a mixing as the arch affords results in a material reduction of the smoke, and under moderate rates of firing will result in almost complete combustion of the combustible gases.

The arch, however, is not sufficient to eliminate smoke when the method of firing illustrated here is followed. A heavy bank of green coal restricts the flow of air at the point where it is most needed and at the time when it is most needed, with the result that most of the hydrocarbons are broken down and the carbon precipitated before being brought into contact with the oxygen entering through the front grates.

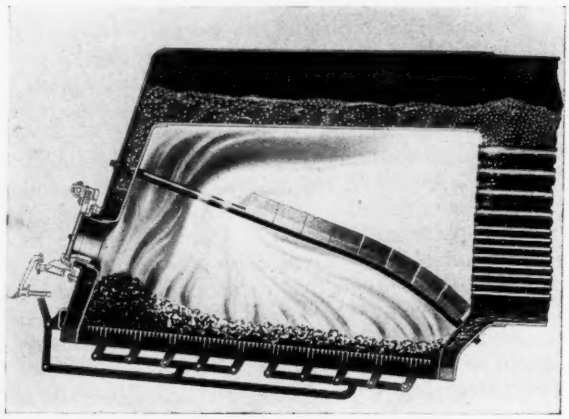


FIG. 2. EFFECT OF ARCH UPON CONDITION OF COMBUSTION WITH FIRE CONDITION AS IN FIG. 1

Figure 3 illustrates the light level fire which should be carried, if smoke is to be reduced to the minimum. With the fuel bed in this condition and a "scatter" type of firing being followed, a uniform air supply is obtained throughout the fuel bed, as well as a uniform distillation

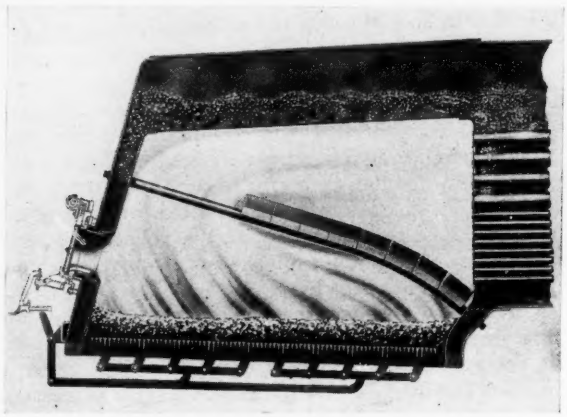


FIG. 3. FUEL BED AS IT SHOULD BE CARRIED

of the hydrocarbons. This facilitates the mixture of the oxygen and the hydrocarbons from the time they leave the top of the fuel bed, the arch mechanically accelerating this mixture.

THE "PERTINAX" pipe, which is one of Germna's latest metal conserving devices, is formed of paper which has been wound spirally around a core and then secured in that form with a synthetic gum. Tests have shown that these pipes will stand the same internal pressure as copper pipes of the same weight and three or four times as great an internal pressure as lead pipe nine times their weight. They are to be used for gas or oil, and for insulating electric wires, and are also being tried out for carrying hot water under pressure.—Machinery.

Compound Steam Engine Problems

DETERMINING CYLINDER DIAMETERS AND STEAM CONSUMPTION. BY G. S. BLANKENHORN

ALTHOUGH a rather simple problem, there are comparatively few engineers outside of designers who can figure out the required cylinder sizes of a compound steam engine, knowing the steam consumption of the unit. This is a rather interesting thing to work out, besides being valuable information for anyone dealing with steam engines and power plants. I have taken an actual case, and worked it through in a way which should make it easily understood by anyone familiar with steam engineering.

Let us determine the cylinder sizes for a compound Corliss steam engine to run at a speed of 125 r.p.m. and to be direct connected to a direct-current generator of 250 kw. capacity. The normal load is to be at approximately the best point of cutoff and the steam pressure at the throttle 150 lb. gage and the vacuum 26 in. referred to a 30-in. barometer.

Determine steam consumption at normal load, first with saturated steam and then with the steam superheated 100 and 200 deg. F. respectively.

Assume a cylinder ratio of 1 to 4; a high-pressure cylinder clearance of 4 per cent; a generator efficiency of 92.8 per cent; a mechanical efficiency of engine of 92.4 per cent, and a card factor of 80 per cent.

CALCULATIONS

(1) The necessary horsepower to be developed by the engine may be found by dividing the generator kilowatt rating, or 250, by the product of 0.746 times the generator efficiency, or 0.928, times the mechanical efficiency of the engine, or 0.924, and as a result we get 391 hp.

(2) Best point of cutoff in high-pressure cylinder is at that point where the engine has completed 23 per cent of its stroke, while the best point of cutoff referred to low-pressure terms is equal to 23 divided by 4 or 5.75 per cent.

We will now consider only the low-pressure cylinder, or in other words, reduce everything to low-pressure terms.

Determine the mean effective pressure corresponding to the low-pressure cutoff of 5.75 per cent. The table for obtaining the value of the theoretical mean effective pressure factor (f) may be used, or if such a table is not available, this may be calculated by means of the following formula:

$$f = \left\{c + \left[(c+m)\ \log_e \frac{1+m}{c+m}\right]\right\}$$

$$= \left\{0.0575 + \left[(0.0575+0.01)\ \log_e \frac{1+0.01}{0.0575+0.01}\right]\right\}$$

$$= 0.2400.$$

c = cutoff = 0.0575.

m = clearance, which in this case is equal to 4 divided by 4, or 1 per cent; therefore, use 0.01.

(3) The theoretical mean effective pressure is equal to $[(P + 10)\ f] - BP$, where P is initial steam pressure in pounds gage (adding 10 to reduce to absolute pressure instead of 15 lb. allows a 5-lb. drop through ports, etc.) and BP is the back pressure in pounds absolute, or $(30 - 26) \times 0.49$, or 1.96.

Theoretical mean effective pressure =

$$[(150 + 10) \times 0.24] - 1.96 = 36.54.$$

(4) Actual mean effective pressure is equal to theoretical mean effective pressure times card factor, which, in this instance, is equal to 36.54 times 0.8, or 29.2.

(5) Area of the low-pressure piston in square inches is equal to the quotient obtained by dividing the product of the indicated horsepower times 33,000, by the product of the actual mean effective pressure times the length of stroke in feet times the number of revolutions per minute times 2. Substituting the values of these various factors, we have the product of 391 times 33,000, divided by the product of 29.2 times 3 times 125 times 2, or 590.

(6) The diameter of the low-pressure piston is equal to the square root of the quotient of 590 divided by 0.785, or 27.4 in., or, let us say, 28 in.

(7) The diameter of the high-pressure piston is equal to 14 in. as the ratio of areas is 1 to 4.

STEAM CONSUMPTION

(8) In order to determine the theoretical steam consumption, we may employ the following formula:

$$\frac{\left\{c + \frac{m}{2}\right\} W \times 13{,}750}{\text{Actual mean effective pressure}}$$

which upon substitution of the values we have of these various factors becomes,

$$\frac{\left\{0.0575 + \frac{0.01}{2}\right\} 0.3638 \times 13{,}750}{29.2} = 10.68$$

(9) The percentage of condensation may be calculated by employing the following:

$$\frac{C\ (T - t)}{L\ O\ W}$$

where C = constant = 16,

T = initial temperature,

t = temperature of exhaust in high-pressure cylinder or the temperature corresponding with the

$$\frac{\text{absolute initial steam pressure}}{\text{cylinder ratio}}$$

or, 160 divided by 4 or 40 lb., the corresponding temperature of which is 267.3 deg. F.,

L = latent heat of steam at initial pressure,

O = cutoff in high-pressure cylinder,

W = weight of 1 cu. ft. of steam at initial pressure.

The condensation in per cent is, therefore, equal to

$$\frac{16\ (363.6 - 267.3)}{858.8 \times 0.23 \times 0.3529} = 22.1$$

(10) Actual steam consumed in pounds per indicated horsepower-hour is equal to $(10.68 \times 0.221) + 10.68$, or 13.04.

(11) With steam superheated 100 deg. F., but with other conditions unchanged, the condensation is equal

to actual condensation in pounds minus, the quotient obtained by dividing the product of 100 times 0.7 times actual steam consumption, by the latent heat of the steam at initial pressure, or

$$2.360 - \frac{100 \times 0.7 \times 13.04}{858.8} = 1.297$$

(12) The actual steam consumed in pounds per indicated horsepower-hour may be obtained by adding items (11) and (8) which gives us 1.297 plus 10.68, or 11.977.

(13) For 200 deg. F. of superheat and other conditions unchanged, the condensation is figured the same as with 100 deg. of superheat, but with the substitution of 0.6 for 0.7 in the above formulas.

To calculate the steam consumption at any other load, the same method is employed. For instance, at half load in the above case, the mean effective pressure would be 29.2 divided by 2, or 14.6. We then determine the corresponding cutoff, and consider a change in card factor from 0.80 to 0.85 (in this case) and go through the calculations as before.

Some Packing Mathematics

By N. G. Near

PACKING is ordinarily considered a simple thing because it looks so easy to pack a stuffing box, so easy to take out and replace the packing again when worn out. Most stuffing boxes are arranged in convenient places for re-packing because engineers seem to think that the best quality of material will wear out in a short time anyway.

Advances are, however, being made right along in the packing line, and we now have good durable metallic material, made of sheet babbit, which absorbs little power and at the same time prevents the steam, water, gas, or ammonia from leaking through.

The principal precaution, though, is that the pump or piston rods should be in good smooth condition before the packing is applied, otherwise it will wear out quickly for the same reason that a babbited bearing will not last long with a rough shaft.

A case came to the notice of the writer where an engineer had been re-packing his stuffing boxes every 6 mo. at a cost of $50, amounting to $100 a year. His piston rods were in what he considered "pretty fair condition" but not perfect, so he didn't bother about having them turned down smooth. He didn't think the condition of the rods had much effect on the cost of the packing anyway.

A friend of this engineer wandered into the plant one day and the subject of packings was brought up. The friend advised the engineer to have his rods all turned down good and smooth and try a better, although more costly packing. That is, the first cost of the packing was more than the cost of the grade he had been ordinarily buying.

The engineer learned that it would cost $45 to have all of his rods turned down and polished, but he got a requisition through for the work and then spent $125 for packing, whereas he had theretofore been paying $50. It looked like an almost clear loss of $120 to him, but he thought much of the advice of his friend and did it anyway.

That was 5 yr. ago. The higher grade of packing is still doing first-class service and the rods are polished brighter than ever because of the nature of the packing.

During these 5 yr. he would ordinarily have spent $500 at the rate of $50 per 6 mo. He therefore saved $330, which is a considerable item, for the cost of the material alone.

Besides, he saved a great deal of money because of the lessened power loss. It stands to reason that a good smooth polished rod absorbs much less power than does a rough rod. Year in, year out, this power loss amounts to a great deal.

This is just one of the many little things in and about the power plant that are worthy of more thought. Many savings can be effected if we just want to take the trouble to study the subject. It usually pays to apply a little mathematics to such matters as these.

Economizer Calculation Chart

By Haylett O'Neill

THE DETERMINATION of the size of an economizer and the checking up of its performance, require a rather complicated formula:

$$A = \frac{2.301\ C_c W_c}{U\left(\frac{C_c W_c}{C_h W_h} - 1\right)} \log_{10} \frac{T_{h1} - T_{c2}}{T_{h2} - T_{c1}}, \text{ in which}$$

A = heating surface, square feet.
U = B.t.u. per sq. ft. heating surface per mean temperature difference per hour heat transfer.
C_c = specific heat of water, 1.0.
W_c = pounds water per hour.
C_h = specific heat of flue gas, 0.24.
W_h = pounds flue gas per hour.
T_{h_1} = temperature flue gas entering economizer.
T_{h_2} = temperature flue gas leaving economizer.
T_{c_1} = temperature water entering economizer.
T_{c_2} = temperature water leaving economizer.

The purpose of the chart is to simplify the calculation.

An example is shown with the chart in which the operating quantities are assumed for the purpose of designing an economizer. To determine the quality of performance of a given economizer, the value of U, or coefficient of heat transfer must be determined.

For example:

Assume: $T_{h_1} = 540$ deg., $T_{h_2} = 361$ deg., $T_{c_1} = 147$ deg., $T_{c_2} = 243$ deg., $W_h/W_c = 1.9$, $W_c = 20{,}000$ lb., $A = 2200$ sq. ft.

From the chart, $U = 2.8$.

In a properly designed and operated installation, U should vary from 3 to 5.

Because of the stoppage of tin imports, Germany is reported to have prohibited the use of solder containing more than 30 per cent tin, and the tin so used must have been recovered from dross or scrap. The making of soldered joints is restricted to cases where lapping, riveting and electric or autogenous welding are impracticable. It is stated that a usable solder can be prepared from 10 parts tin, 80 parts lead and 10 parts cadmium.

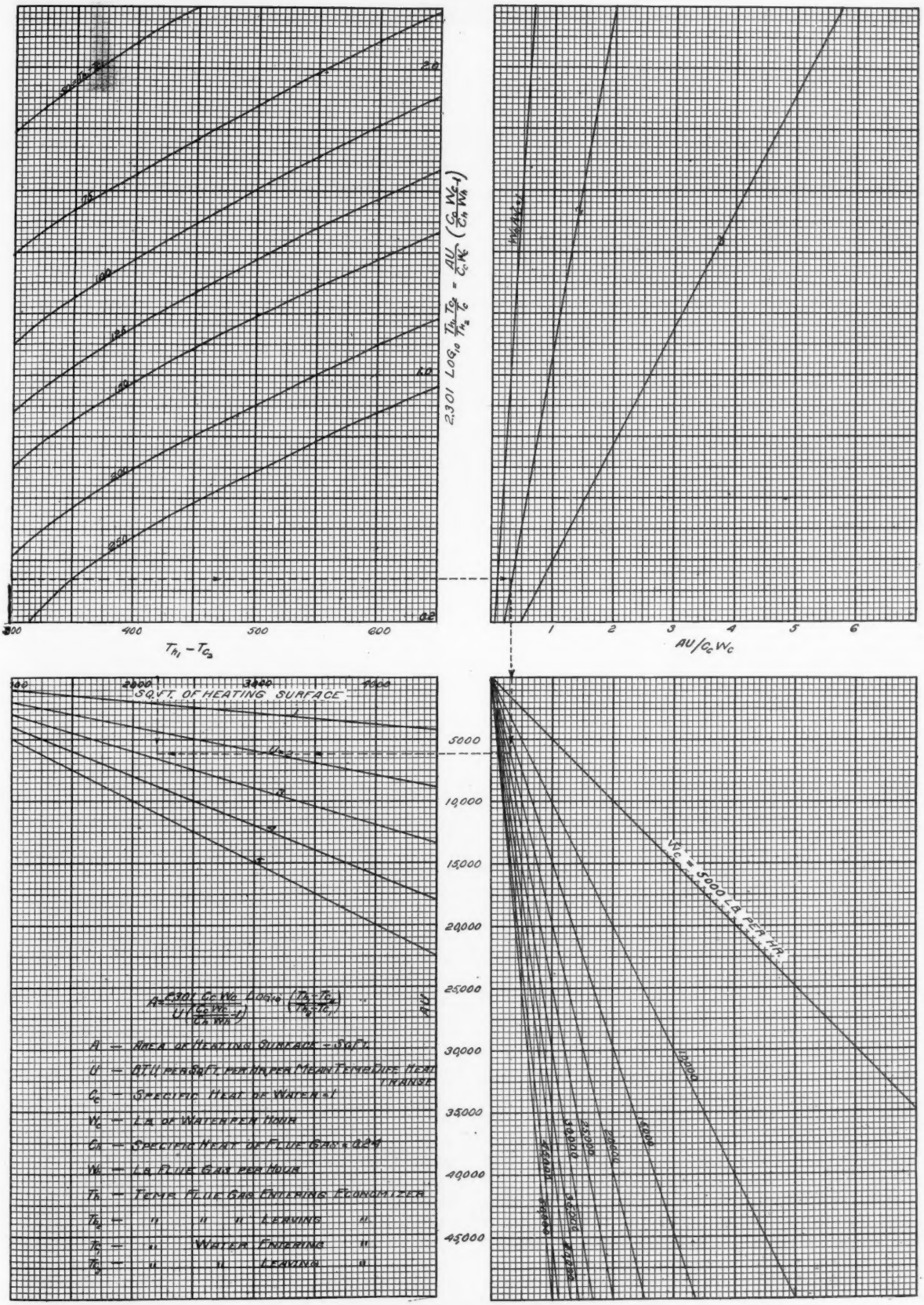

$2.301 \log_{10} \frac{T_{h_1} - T_{c_2}}{T_{h_2} - T_{c_1}} = \frac{AU}{C_c W_c} \left(\frac{C_g W_g - 1}{C_g W_g} \right)$
$T_{h_1} - T_{c_2}$
$AU / C_c W_c$
SQ. FT. OF HEATING SURFACE
W_c = 5000 LB. PER HR.
$A = \frac{2.301\ C_c W_c \log_{10} \left(\frac{T_{h_1} - T_{c_2}}{T_{h_2} - T_{c_1}} \right)}{U \left(\frac{C_c W_c}{C_g W_g} - 1 \right)}$
A = AREA OF HEATING SURFACE - SQ. FT.
U = B.T.U. PER SQ. FT. PER HR. PER DEG. MEAN TEMP. DIFF. (HEAT TRANSM.)
C_c = SPECIFIC HEAT OF WATER = 1
W_c = LB. OF WATER PER HOUR
C_g = SPECIFIC HEAT OF FLUE GAS = .24
W_g = LB. FLUE GAS PER HOUR
T_{h_1} = TEMP. FLUE GAS ENTERING ECONOMIZER
T_{h_2} = " " " LEAVING "
T_{c_1} = " WATER ENTERING "
T_{c_2} = " " LEAVING "

CHART FOR COMPUTING ECONOMIZER VALUES

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Lightning Protection---I

TYPES OF APPARATUS EMPLOYED AND THEIR PRINCIPLE OF OPERATION. BY TERRELL CROFT

THE TERM lightning protector is used in preference to lightning arrester in this discussion because it appears that the latter designation more accurately describes the service which the apparatus in question renders. The word "arrest," according to the dictionary, means "to stop action of," and so-called lightning arresters do not in every case stop the action and effects of lightning nor does any manufacturer of such make the claim that they are infallible. They do, however, afford protection or insurance against lightning damage to electrical apparatus. The measure of protection which is afforded is determined to a considerable extent by the investment which can be made in protective apparatus to supply the protection. In this respect the cost of protection against lightning is similar to the cost of protection against fire or accident. We will, therefore, in what follows, refer to lightning protectors rather than to lightning arresters. The term lightning has a specific significance when used in connection with electrical apparatus protection. When thus used, "lightning" implies any sort of excessively high-voltage disturbance in an electrical generation, transmission or distribution system.*

Lightning may be divided into two general classes, atmospheric lightning and internal lightning. Each of these may be defined as follows:

Atmospheric lightning is that due to the equalization of a difference of potential between two oppositely electrified clouds or between a cloud and the earth. The lightning strokes or lightning flashes with which everyone is familiar are manifestations of these phenomena.

Atmospheric lightning may affect an electrical system in either of two ways—by a so-called direct stroke or by an induced stroke. A direct stroke is one where a lightning-discharge current between a cloud and the earth selects, for a portion of its path, a part of the electrical system. Then, that system is said to be "struck by a direct stroke." Lightning protectors are not, as a rule, capable of affording absolute protection against direct strokes. If the current of a direct stroke passes through a lightning protector, usually that protector is destroyed. Direct strokes ordinarily strike only aerial pole lines. An overhead ground wire strung (Fig. 1) above, or adjacent to, the pole line and connected with the earth at frequent intervals affords the most effective protection against direct strokes. Observation has indicated that the current of a direct lightning stroke will not flow along a transmission line for a very great distance. It will usually find, through some insu-

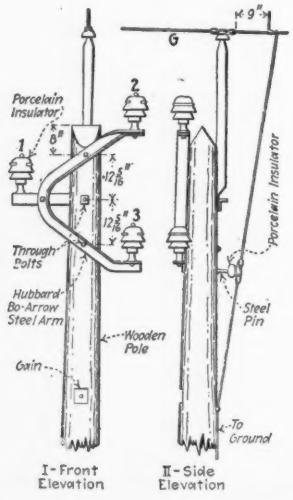
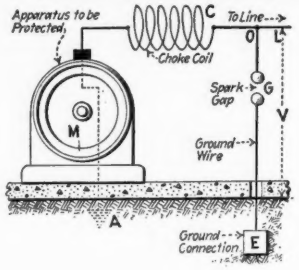


FIG. 1. GROUND WIRE OVER A THREE-PHASE TRANSMISSION CIRCUIT (THE LINE WIRES TAKE POSITIONS 1, 2 AND 3)



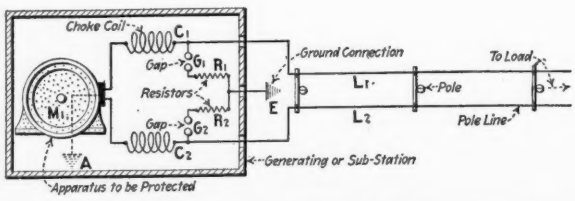


FIG. 2. APPLICATION OF THE ELEMENTARY LIGHTNING PROTECTOR

FIG. 2A. DIAGRAM INDICATING TYPICAL ARRANGEMENT OF LIGHTNING PROTECTION EQUIPMENT

*Commercial lightning protectors are designed to protect only against the effects of transient abnormal voltages. They are not, as a rule, designed to protect against the effects of continued abnormally-high voltages, regardless of how such high voltages may originate.

lation breakdown, a path to earth a relatively few feet away from the point where it "struck" the line.

An induced stroke is one whereby an abnormally high potential is developed on the electrical system, due to induction, by an atmospheric lightning discharge. Protection against the effects of induced strokes is usually satisfactorily provided by a suitable lightning protection apparatus. The induced are much more common than the direct strokes.

Internal lightning, so-called, is any abnormal voltage rise due to changes in the load on the electrical system. Examples of internal lightning are the abnormal conditions due to excessively high voltages which may occur, particularly in high-voltage systems, and which are caused by the opening or closing of switches or by an intermittent ground. Internal lightning effects are sometimes called surges.

A lightning protector is an electrical safety valve. The duty of the protector on an electrical system is to relieve the system of abnormally high voltages, in a manner somewhat analogous to that in which a safety valve relieves a steam boiler of an excessively high pressure. Just as the safety valve should stop the escape of steam after the abnormal conditions have been relieved, so should a lightning protector stop the flow of current after the high potential has been relieved. Thus, any device which will, under the influence of a voltage above normal, permit current to flow through it and which will, when the abnormal condition ceases to exist, stop the flow of that current, constitutes a lightning protector.

How a lightning protector protects may be understood from a consideration of the diagram of Fig. 2. Assume that, due to some cause or other, the potential of the line L becomes much higher than that of the earth or ground. That is, assume that an abnormally high voltage, V, exists between the conductor, L, and the earth underneath it. Such a high voltage might originate either from atmospheric or internal lightning, as above described. The tendency of this voltage would be to force a current from L to the earth. This current would select the path of least opposition. If there were no protection apparatus associated with the line, the path of least opposition to ground would, probably, be through the windings of the generator, M, to its frame and thence to earth, A, as shown by the dotted lines. That is, the high voltage would break down the insulation of some of the windings of M and force a current through them to ground. This would damage the machine and might, possibly, "burn it out." Now if an air gap, G, were connected between the line wire and ground, as shown, the path LGE through the gap to ground would probably offer much less opposition, to the flow of the lightning-discharge current, than would the path LCMA through the generator to ground. The reason for this is that the path through the generator would probably be one of relatively high inductance, whereas the path through the air gap, G, to ground would be one of practically no inductance. Lightning discharge currents are always of high frequencies or the equivalent thereof; hence, a path containing inductance offers great opposition to their flow. It is a fact that the electrical opposition, that is, the impedance offered by an inductive circuit to the flow of an alternating current, increases as the frequency of the current increases. Therefore, the abnormal potential on L would probably be relieved by a flow of high-frequency current through G to the ground, E. The air gap, G, is long enough to prevent its breakdown and a flow of current under normal conditions. Figure 2A will give a better idea of actual conditions. The resistances, R_1 and R_2, are provided to limit the current so that after the abnormal voltage conditions has been relieved the generation, M_1, would not force current along path $G_1R_1R_2G_2$. If these resistances or their equivalent were not provided, the generator might continue to force current along the path shown even after the abnormal voltage condition had been relieved. The reason is that after an electric arc has been established across a gap, a relatively small voltage is sufficient to maintain it. A number of different devices which are used in practice as an equivalent for the spark gaps illustrated in Figs. 2 and 2A and some schemes utilized for preventing the flow of current after the high voltage has been relieved, are described in succeeding paragraphs.

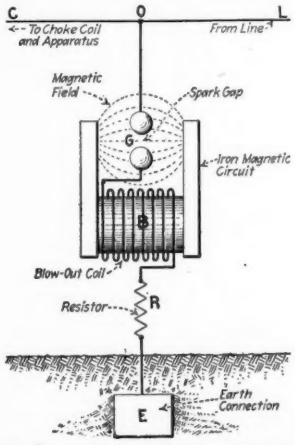


FIG. 3. ILLUSTRATING THE PRINCIPLE OF THE MAGNETIC BLOW-OUT LIGHTING PROTECTOR

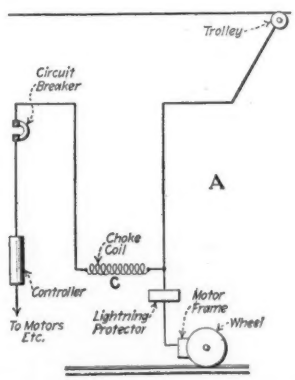


FIG. 4. PROTECTOR ON TROLLEY CAR—MOST DESIRABLE ARRANGEMENT

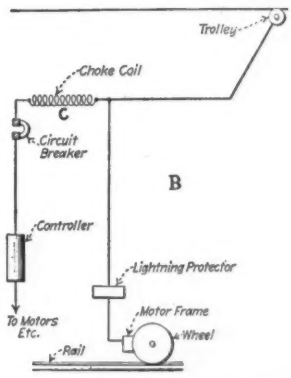


FIG. 5. PROTECTOR ON TROLLEY CAR, AN ARRANGEMENT WHICH MAY BE USED INSTEAD OF THAT SHOW IN FIG. 4

Instead of there being a difference of potential between the line, L_1L_2 (Fig. 2A), and the earth there might be an abnormal difference of potential or voltage (internal lightning) between L_1L_2. If the gaps, G_1 and G_2, were not provided this excessive pressure might break down the insulation in M and damage it. But with the gaps G_1 and G_2 in place, the equalization current would flow along $G_1R_1R_2G_2$ so that then the machine would not be damaged.

The function of a choke coil, C_1C_2, Fig. 2A, in lightning protection is to increase the inductance, therefore opposition, of the circuit in which it is inserted. It thereby tends to force the "high frequency" lightning current to ground through the lightning protector. If a surge, due to external or internal lightning, travels along a transmission line, it induces a very high voltage in any inductive winding which it encounters. Hence, unless choke coils, which are specially designed to provide this inductance, are inserted between the line and the apparatus (transformers or generators) the high voltage is likely to be induced in the turns of the apparatus and cause an insulation breakdown and consequent damage. Such damage may be extremely serious if the current circulated by the generators on the system follows the path provided by the abnormal voltage. Where choke coils are inserted as shown in Figs. 2 and 2A the high voltages will be induced in the ends of the choke coils. Damage to the choke coils should not, however, occur, because the coils are specially designed to withstand these abnormal conditions.

An important distinction between an alternating current and a direct current from a protector standpoint is that the alternating voltage decreases to zero twice in each cycle, whereas a direct voltage is always in the same direction. The consequence is that the arc sustained by a direct-current generator through a spark gap after the lightning discharge current has passed is more difficult to extinguish than the arc similarly sustained by an alternating-current generator; that is, it is more difficult to stop the flow of a direct current through the spark gap of a lightning protector than it is to stop the flow of alternating current. How these characteristics are recognized in the design of lightning protectors will be described, first the direct-current types, then the alternating.

A magnetic blowout direct-current protector is shown diagrammatically in Fig. 3. The spark gap, G, is connected in series with a blowout coil, B. When air gap, G, is broken down by an abnormal voltage, current flows from the line via OGBR to earth, E. The tendency is for the current impelled by the direct-current generator to continue to flow across G. However, B develops a magnetic field as shown. An arc cannot exist in a sufficiently strong magnetic field. The power-current (generator current) arc is, therefore, "blown out" by the field. The resistance, R, limits the current.

Lightning protectors on electric railway cars may be arranged as shown in Figs. 4 and 5 to protect the apparatus on the car. Protectors should also be installed at intervals along the trolley line. Note that choke coils, C, constitute part of the car equipment.

A carborundum-block protector, which may be used on either direct or alternating-current circuits operating at pressures not exceeding 750 v., is shown in Fig. 6. This has been designated by its manufacturer as a multipath protector, because of the fact that there are many paths provided to ground for the lightning discharge current. It consists of a disk or block, B, of carborundum granules bound together with a dielectric binding compound. On either face of the protector is mounted a metal terminal plate, P_1 and P_2. A small gap, G, is provided for line voltages of from 400 to 750. The two terminals, E and L, are connected to ground and line, respectively. When under the influence of an abnormally high voltage the dielectric is broken down, the protector operates, permitting current to flow. When the abnormal voltage is equalized, the current flowing through the block ceases because the many minute electric arcs through the block cannot be maintained by the generator pressure.

The condenser-type protector, for direct-current circuits, is diagrammed in Fig. 7. These protectors are

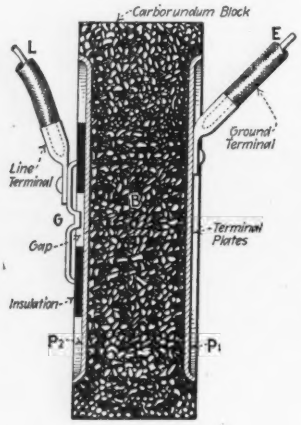


FIG. 6. SECTIONAL VIEW OF CARBORUNDUM—BLOCK PROTECTOR

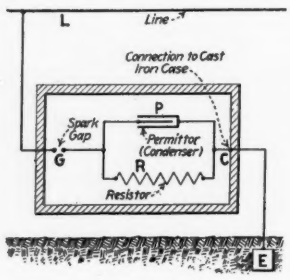


FIG. 7. THE CONDENSER TYPE PROTECTOR

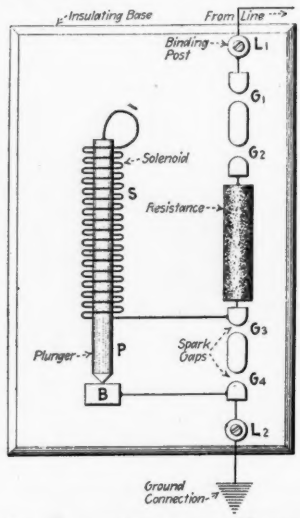


FIG. 8. DIAGRAM OF "CIRCUIT BREAKER" TYPE LIGHTING PROTECTOR

designed particularly for circuits operating at pressures of from 750 to 1500 v. It consists merely of a spark gap, G, in series with a resistor, R. However, the resistor is shunted by a permittor (condenser). The spark gap prevents the flow of current through the protector when the voltage is normal. When the voltage becomes abnormal, current is forced across the gap and the permittor permits free discharge of the high frequency lightning current to ground. The direct generator current cannot flow because it cannot pass through the permittor and the resistance of R is so great that even if G is short-circuited the direct current which will flow is negligibly small. The real function of R is to maintain the permittor in a discharged condition. Protectors of this general type but without the spark gap are also manufactured and are recommended for the protection of apparatus having weakened insulation.

The "circuit-breaker" type lightning protector is shown diagrammatically in Fig. 8. This design comprises essentially four air gaps, G_1, G_2, G_3 and G_4, with a resistance between them. The assembled device is shown in Fig. 9. The 2 gaps, G_3G_4, on the ground side of the current-limiting resistor, have connected in multiple around them a solenoid, S (Fig. 8). When a current of sufficient intensity passes through S, the iron plunger, P, is lifted by the magnetic effect thereof and then opens the circuit at B. It is due to this device that the protector is called the "circuit-breaker" type. When the protector is discharging the high-frequency current of a line at abnormal voltage, practically all of this current passes directly through the path $L_1G_1G_2G_3G_4L_2$ to ground. The inductance of the solenoid S is so high that practically none of the high-frequency current will go through it. However, if the power current follows the lightning discharge current through the protector, this power current will not, because of its low frequency, pass across gaps G_3G_4, but will, in preference, take the path of lesser opposition through S. Thereby the plunger is raised and the arc extinguished.

(To be continued.)

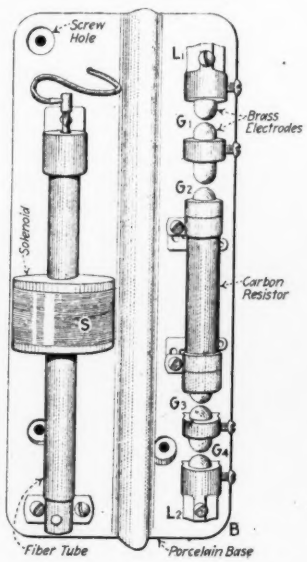
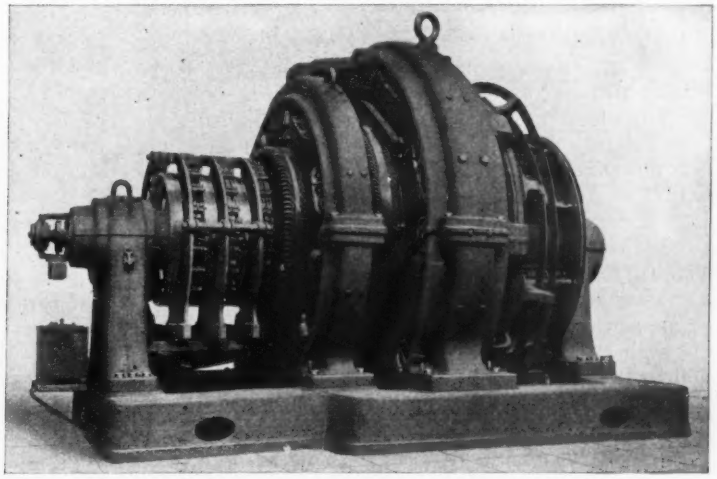


FIG. 9. THE GARTON-DANIELS LIGHTNING PROTECTOR

Westinghouse Synchronous Booster Rotary Converter

SYNCHRONOUS booster rotary converters are well adapted for any application for which a relatively wide, automatic or non-automatic variation in direct-current voltage is necessary. They are particularly desirable for serving incandescent lighting systems where considerable voltage variation is required for the compensation of drop in long feeders, for operation in parallel with storage batteries and for electrolytic work where extreme variations in voltage are required by changes in the resistance of the electrolytic cells. They can be used for supplying Edison 3-wire systems, and are recommended in preference to either 2 or 3-machine motor-generator sets.

Synchronous booster rotary converters manufactured by the Westinghouse Electric & Mfg. Co., consist of a shunt-wound rotary converter in combination with an alternating-current generator mounted on the same shaft with the rotary converter and having the same number of poles. By varying the field excitation of this alternating-current generator, the alternating-current voltage impressed on the rotary converter proper can be increased or decreased as desired. The direct-current voltage delivered by the converter is thereby varied accordingly.



WESTINGHOUSE SYNCHRONOUS BOOSTER ROTARY CONVERTER

Standard synchronous booster rotary converters are wound for 270 v. direct-current, with a range of 240 to 300 v. and for the desirable and usual converter ratings of 500 kw. and above both for 25 and 60 cycles. As previously stated, the direct-current voltage range can be made of any desired value by properly proportioning the booster generator capacity. For extreme voltage ranges, special booster converters are required. It is rarely practicable to obtain more than 15 per cent buck or boost. The standard variation is a total range of 20 per cent; that is, 10 per cent below and 10 per cent above the average voltage for which the converter is designed. This range is obtained by a boosting generator with a capacity of 10 per cent of that of the converter.

Compared with the transformer or induction regulator method of voltage regulation, the booster rotary

converter method has the following advantage: There is only one unit, which requires minimum floor space and cable connections. This simplifies installations as there are no connections to make between several pieces of apparatus. The booster converter has rugged characteristics. With induction regulators dangerous forces may be developed between the stator and the rotor if the converter is connected to the alternating-current line while out of step.

Compared with the so-called regulating-pole or split-pole converter method of regulation, the synchronous booster rotary converter possesses higher efficiency, particularly at the lower voltages, and has better commutation, particularly at maximum voltage and load. This advantage is further increased by the possibility of using commutating poles whenever large capacity or other conditions make commutating poles advantageous.

Oil Engines

SOME POINTERS RELATIVE TO THEIR OPERATION. BY SPARK

INTERNAL COMBUSTION engines, particularly those of the semi-Diesel oil-burning types, have been introduced into many manufacturing establishments, either replacing steam entirely, or being used for some special purpose such as taking care of additional installations of machinery, and have proven efficient and reliable, and very economical if proper designs were selected. It behooves steam men to gain some knowledge of the possibilities and operation of this source of power so rapidly increasing in favor, and the subject is one which will prove exceedingly interesting to the student.

While the straight Diesel engine is undoubtedly the most economical in operation, the first cost is high, and it is not used much in small powers owing to the necessity of high pressure, multi-stage air compressors, etc. Here the semi-Diesel engine, with its absence of all costly auxiliaries, enters the field, and with its low first cost, simplicity (in some types a pronounced feature), ease of operation and good economy, proves an almost ideal prime mover. These engines operate on almost any fuel oil, such as distillate, light crudes, kerosene or alcohol, and most will develop a horsepower on considerably less than a pint an hour, a pint being considered about the consumption in the ordinary gasoline engine, and with gasoline at its present price or even its average price, there is no comparison between the two in cost of fuel.

One of the principal differences between the semi-Diesel and the gasoline engine is in the manner of mixing and taking the charge of air and fuel. In the latter, the gasoline and air are mixed outside the cylinder in the carburetor and drawn into the cylinder as an explosive gas; while in the Diesel and semi-Diesel engines, pure air is drawn into the cylinder and partly compressed before receiving the jet of fuel. The fuel supply is fed by a plunger pump operated by cams or other intermittent device, and the regulation of speed is obtained by shortening the length of the plunger stroke, or by holding the suction valve of the oil pump open and so allowing oil to "churn" in the pump instead of going to the cylinders. Small centrifugal governors are used, and the regulation may be made very close, permitting the use of these engines for driving dynamos for electric lighting.

Another difference is in the manner of ignition, and here lies a drawback against its use for any work which requires frequent shutting down and quick starts, unless the work is of such a nature that a clutch may be used as in marine work. In the semi-Diesel engine, ignition is from the heat of a "hot-ball" or point or tube in connection with the heat of compression, and before starting, this "hot-ball" must be heated to red heat by a blowtorch, requiring from 5 to 15 min. for the operation. After starting, the heat of the explosions maintains the ball red without further use of the torch.

A peculiarity is in the use of a feed of water into the cylinder which serves a double purpose. As stated above, ignition is from a combination of two heats, that of the compression, and that of the ball or point. When the heat of compression reaches a certain degree, in connection with the heat of the ball, it will fire the charge, and the principal use of the water is to regulate the point of the stroke at which this temperature is reached, thus retarding or advancing ignition. The amount of water admitted can be very closely regulated to obtain ignition at the proper point in the stroke, which should be somewhat before the dead center, thus giving time for the more complete combustion of the charge and best economy. If too little water be admitted, the compression reaches its firing heat too soon, causing knocking and loss of power, while too much water causes ignition to occur late, resulting in loss of power, and sometimes cooling of the ball to such an extent as to stop operation. The secondary use of the water is to prevent the formation of carbon, which it does very effectually. The exact operation of the water vapor on the carbon is not understood clearly; but it is advanced that the decomposition of the water by the heat forms oxygen, which attacks the carbon and under the great heat burns it out, much as carbon is burned from automobile cylinders by oxygen.

The usual design is vertical, and after the conventional two-cycle gasoline engine style, with wristpin in piston and enclosed cranks; but by far the best all around design where floor space can be spared, is the horizontal engine built after steam engine practice, with piston rod, crosshead and outside cranks. In such an engine nothing is concealed but the piston; bearings and cranks can be adjusted and reached as easily as in any steam engine, and things are generally more satisfactory. One engine of this type I consider the best of seven makes I have come in contact with. Practically every part is exposed, all members are of good proportions, and it is as near fool proof as can be. It runs along merrily hour after hour, requiring no adjustment, and no attention but periodical oiling and a glance at the cylinder water feed.

After about 100 hr. run, a horizontal engine refused to start, not enough compression being obtained. The piston was removed, with expectation of finding the ring broken. The rings were all right, but upon measuring the cylinder it was found considerably out of round,

enough to lose the compression. It was then found that, fresh water being scarce, salt water had been used for the cylinder feed, the solids in which had worn the cylinder. The cylinder had to be bored, and a new piston and new rings furnished, fresh water feed supplied, and the engine has run thousands of hours since, still maintaining good compression. Cylinder feed should be as free from sediment or solids as possible, and good quality of gas engine oil used.

A stoppage which caused considerable inconvenience was due to the use of an improper oil. It was reported that the engine ran all right light, but would not take her load. We examined the governor, feed pump, nozzles, etc., and found all O. K. The engine was started again and the exhaust was found to be very black and throwing flakes of carbon. Trouble was at once apparent, and upon removing clean-out plates over the air inlet ports in the cylinder, the ports were found to be reduced to about ⅓ their proper area by a hard deposit of carbon, which was removed by chiseling. The engine was then started and ran as well as ever. Discovery was made that wrong oil had been supplied, being a compound oil for marine engine work instead of the gas oil called for. The animal or vegetable oils used for compounding burned into the hard mass in the ports.

Another operator said that his engine pounded so that he was afraid to run it. Two minutes sufficed to set him right. The cylinder feed in that type of engine was through a needle valve into a sight-feed glass for observation, and he had allowed the glass to become so fouled with oil and other dirt that the dropping of the water could not be seen. He had adjusted the needle valves and assumed that the adjustment was correct over several days running, when as a matter of fact the orifices had become stopped with dirt and no water at all was reaching the cylinders, causing preignition and a bad knock.

It is an economy in the operation of these engines to have a good supply of piston rings made up at one time, and replace them one at a time, even before they are actually required. In this manner good compression may be obtained almost indefinitely, as the three or four rings which fit the cylinder will drag the new one till it also fits, and then one of the others can be replaced. If an entire new set be put in, it may happen that the compression obtained is so poor that the engine cannot start, owing to the new rings not fitting the oval shape of the cylinder; then it's a case of reboring and making new piston and rings.

Any man with the mechanical ability which a steam engineer must possess, and a little study of the principles of the internal combustion engine, can successfully operate the semi-Diesel engine with no more nor less care than a steam engine would require, and an up-to-date man will endeavor to possess at least the theoretical knowledge of such operation.

WE DENY the possibility of perpetual motion, but the earth continues to revolve on its axis and to pursue its course through its orbit. Then why cannot man start something similar? The answer is friction, which man cannot entirely overcome. A meteorite travels through space for ages, but so great is the friction when it strikes our atmosphere that it becomes highly heated and frequently disappears in vapor.—The Gas Engine.

Accidents Caused By Leaky Valves

BY H. A. JAHNKE

IT seems to be the practice in some power and manufacturing plants where steam is used to pay little attention to a leaky valve until it interferes with the operation of the plant. This is bad practice and should be avoided whenever possible, as it is dangerous and expensive. A valve, no matter how small or large, should be reground or a new disc placed as soon as a leak appears, or as soon thereafter as possible; otherwise the seat may be cut badly by the steam, making the valve worthless. If a valve is repaired immediately after it shows a leak very little work and expense will place it in good condition.

THROTTLE VALVE LEAKED

I REMEMBER one case where a throttle valve on a small slide valve engine leaked badly, nearly causing serious damage. One night after shutting-down time, it was necessary to remove the crosshead boxes to file a little off them to allow for keying up. After the crosshead and piston were free from the connecting rod, the piston shot against the back cylinder head, due to the fact that the throttle leaked so badly that there was enough pressure against the piston to force this with a loud report against the back head. After examining all parts, it was found that a few studs which held the head were broken. These were replaced quickly, but we were lucky no other parts were broken, such as the follower plate or cylinder head. The valve was repaired immediately after this.

VALVE ON TOP OF BOILER LEAKED BADLY

AT ONE TIME I happened to go into a plant where a number of horizontal return tubular boilers are in use. One boiler was down for cleaning and they were trying to knock in the top manhole plate, but were unable to do so. Upon inquiring why they did not remove all the pressure from the boiler before trying to remove the plate, I was told that it could not be done, as the stop valve in the steam pipe connecting this boiler to the steam header leaked badly. I did not remain in the plant until they got the plate out; but I was wondering later how they could give the boiler a thorough washing out with the valve leaking badly, as no one could enter the boiler; also, judging from appearances, the valve must have been leaking for a long time.

STOP AND CHECK VALVES LEAKED

ANOTHER INSTANCE was in a plant containing one boiler, where a leaky stop and check valve in the feed line near the boiler caused much trouble and expense. On a Sunday the boiler was cleaned and filled with water, as some repairs were needed on the feed line between stop valve and closed feed water heater. It was decided to make these repairs during the time steam was raised; but unexpected pressure was in the boiler before the repairs were finished, when water and steam started to come out at the end of the feed pipe where this was disconnected. At first, it was thought that the stop valve was open; that, however, was not the trouble. As the valve and check valve leaked badly, to finish the repairs

on the feed line, the fire had to be drawn, steam let out of the boiler and water lowered some to prevent this from coming out of the feed pipe. After examining the check and stop valves, it was found that they could not be repaired, as the disc and seat were cut badly. As there were no new valves in stock, the old valves were left in place until the next boiler cleaning, then replaced by new valves. Had these valves been looked after and repaired long before, it would have saved much trouble and expense, considering the steam, hot water and time wasted. In a case of this kind, should anything go wrong with the check valve, such as the bonnet blowing off, stop valve leaking badly and boiler in operation, it would be dangerous, also making it necessary to place the boiler out of operation. For this reason, the stop valve and check should always be examined at each boiler, cleaning, then repairing or replacing by new valves, whichever is necessary.

Pump Throttle Valve Leaked

The writer had much trouble with a boiler feed pump which started to give trouble during the time it was needed most. As there was only one pump in the plant, another was sent for immediately to take its place. When this arrived, it was decided to install it at once; but on disconnecting the pipes of the disabled pump, it was found that the pump throttle and the valve next to the main steam pipe leaked badly, making it impossible to disconnect this pipe from the pump. Since this was receiving steam out of the same pipe as the engine, the valve on top of the boiler had to be closed, closing down the plant for some time until the throttle and valve near the main steam pipe leading to the pump were replaced by new valves. All this trouble and shut-down could have been prevented if one of the valves had been tight, as I have replaced a disabled boiler feed pump and others many times by filling the boiler with as much water as was possible with the troublesome pump, if it was still able to do this, then disconnecting all pipes, placing and connecting up another pump without interfering with the operation of the plant. Of course, this cannot be done if all pipes are not provided with a flange or union near the pump and all valves are steam and water tight. This also shows that it is bad practice to allow a boiler feed or any other pump to be run down so low that there is danger of its giving out while it is needed badly. It is better to examine the pump at times, then make repairs when it is not in service. In this way, it is not necessary to replace a disabled pump during the time the plant is in operation, as there is always more or less danger in disconnecting the pipes on a pump under pressure. Of course, where there is more than one feed pump in the plant, it is an easy matter to make repairs when the pipes are not under pressure; for if one pump gives out, the other is used while the disabled one can be repaired at will when there is no pressure in any of the connecting pipes. As the pump in the above case was not in operation during the night, and, from the appearance of the valves they had been leaking for a long time, I believe enough steam was wasted during this time to pay for several new valves.

I am quite sure these conditions exist in many other plants where a number of valves leak badly, but no attention is given them, which shows there is bad management in these plants.

Another point where a leaky valve may cause much trouble and burned fingers, is the water gage glass valves on a boiler, should the glass break during the time the boiler is in operation, and at times these valves leak so badly that it is impossible to place a new glass, making it necessary to close the valves in the water column connections, if there are some. The gage valves should be examined at boiler cleaning, then repaired or replaced by new valves, whichever is necessary.

Fixing the Boiler-Tube Cleaners

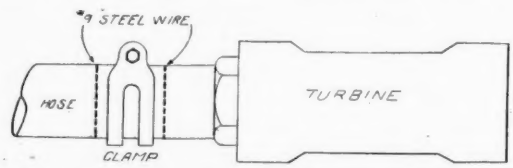
By Jack L. Ball

BANG! Thud! The air hose had slipped off the boiler tube cleaner for the third time in as many hours, and Spike, the boiler foreman, had been thrown to the boiler room floor again, a distance of about 8 ft.

"I'm through with the whole outfit; I've quit," said Spike after he had gotten to his feet and regained his breath. "We cut the air pressure from 125 to 110 lb. and still we can't keep it fast."

"Not so fast me b'y," replied Casey, the fireman. "You just watch the steam awhile an' I'll fix ye up so that ye won't have nary a bit more trouble."

Casey secured a brace, a 3/16-in. drill, and a piece of No. 9 steel wire. He took off one of the two clamps, loosened up the other one and then put the hose in position on the cleaner. He then drilled two holes about



MANNER IN WHICH CASEY SECURED THE TURBINE HOSE

1 in. apart through the hose and the connection on the turbine. The clamp was drawn tight, and then the wire was put through the holes and made secure.

"Now, me b'y," said Casey, "since ye've had so much trouble with the hose on the water-driven turbin', I'll fix that one while I have the chance."

Casey secured a 1¼-in. nipple about 1 ft. long. One end he dressed on the emery wheel so that it just made a snug fit in the 1½-in. water hose. He then heated the nipple to a medium cherry red, quickly placed it in the hose the desired amount and immediately drenched it in cold water. This made a permanent weld between the hose and the nipple. As one end of the nipple had previously been threaded, it was only necessary to screw on the turbine.

"By the way," asked Casey a few weeks later, "is the air hose still holding out"?

"Fine and dandy," answered Spike. "It is as tight as the day you put on the wire."

Dr. Diesel, in inventing his cycle, attempted to follow the Carnot cycle, but in reality, his engine developed until it now follows closely the Joule cycle, the most efficient known.—The Gas Engine.

Using Two Engines for One Generator

By J. C. Hawkins

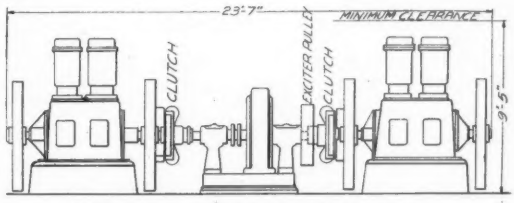
IN looking over the specifications submitted for the installation of a new municipal power plant, several interesting ideas were brought to my attention. The load would warrant the installation of about 75 kv.a. capacity; but, as a spare unit should be provided for 24-hr. service, it was proposed to install one 75-kv.a. unit at first, and run it 18 to 24 hr. a day until a second and larger unit could be installed when more funds were available.

The plan which attracted my attention as being the best in every respect was that of a gas-engine plant, consisting of one 125-hp. gas producer to use anthracite coal, one 100-kv.a. alternator direct connected through friction clutches to 2 2-cylinder vertical producer gas engines of 70 hp. each, one on either side of the generator. The idea was to use a producer of about the capacity of the entire unit at full load, and either one or both of the engines as required to drive the generator through the friction clutches.

It was admitted by the builder that a gas engine has a comparatively narrow range of economical load limits, and if operated at ½ load or less was wasteful of fuel. The guarantee of fuel consumption was 2.75 lb. per kilovolt-ampere at half load or less and 1.6 lb. at full load. Through this arrangement, when the load was light one engine could be used alone to drive the generator with the engine operating at a good load factor, and as the load increased beyond the capacity of one engine, the other could be put on and operated in parallel, driving the one generator until the peak dropped off, when one engine could again be cut out. This would give a higher load factor on the engines and would reduce the fuel per kilowatt-hour from what it would be with the engine running at light load. This plan would not be feasible in all plants, and a separate generator for each engine would be preferable, selecting units of the proper size; but this plan was advocated to reduce the initial cost, and at the same time secure economical operation. In the electric light plant of a small town there usually occurs a high peak between the hours of 4 and 11 p.m. with the balance of the load quite uniform. This idea could be worked out to give a high engine load factor and provide 24-hr. service with a minimum amount of equipment. The generator would not be quite as efficient when running at light load as at full load, but the economy does not vary as sharply from half load to full load as it does in gas or oil engines. Another advantage is that the cost of the generator switchboard and plant wiring would be less than with 2 generators, and less floor space would be required.

It was further proposed, as the load increased beyond the capacity of the combination unit, to install a second unit of such capacity as load conditions would warrant, consisting of one 4-cylinder engine direct connected to a generator of the proper capacity, and a second producer. The producers would be cross connected so that either or both could be operated if necessary, with the second unit used to carry the average load at its capacity with the old one as a reserve to be used during the peak load period. In this way, there would be 3 economical rated engine capacities available, and it would be possible to operate at nearly full engine capacity at all times. Plans and considerable data were submitted from 2 or 3 plants having this arrangement of units, as evidence that the plan had been successfully worked out.

This scheme has, however, some disadvantages; the principal one, which would seem to discourage its use, especially in a municipal plant, is that the entire distribution system consists of outside pole lines subject to danger from lightning, although the generator and switchboard would be protected by lightning arresters; but there is a possibility that the generator might be disabled from this or other cause, which would put the entire plant out of commission. Another disadvantage is that the generator and producer would need some attention, and especially the exciter, and it would be necessary to kill the entire system while repairs were being made. This, however, might not occur very often, and would not cause serious difficulty in a small town, as there would be, in this case at least, little commercial motor load, and many small repairs could be made after midnight.



2-ENGINE, SINGLE-GENERATOR UNIT

The idea of using 1 generator with 2 engines to get a plant within the available money looked so promising that it was taken up with the builder of a semi-Diesel engine who builds engines as small as 50 hp.; he advised that while 2 units would be better, it could be worked out to give a wide range of economical load factor and for a small plant might prove to be more economical than installing 2 separate units. He further stated that several installations of this kind had been made and were successful.

If the Diesel engine were used instead of the gas engine, the trouble due to the gas producer would be eliminated and the probability of continuous service would be greater. Diesel engines, however, are higher in first cost than gas engines and the first cost of an installation of this kind would be considerably higher than 2 steam driven units according to the estimates furnished. The overload capacity of the steam plant would be greater, but the efficiency probably less.

THE SUITABILITY of any particular fuel may be determined by its tendency to cause smoke emission or to produce objectionable clinkers under some conditions, or by other factors. Frequently, however, a fuel considered unsatisfactory by the operating force in a given plant may, when differently handled prove to be suitable. This statement applies to power plants or heating plants of considerable size, but is just as true when applied to residence heating conditions and equipment.—Bureau of Mines Yearbook.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Setting Corliss Valves with Piston Stationary in Any Position

ENGINEERS are often confronted with the job of setting the valves of an engine of such large size that it is a cumbersome job to move the crank from one center to another and may require from one to a half dozen men to do it, and many such necessary jobs are put off because this "molehill" is magnified to a "mountain."

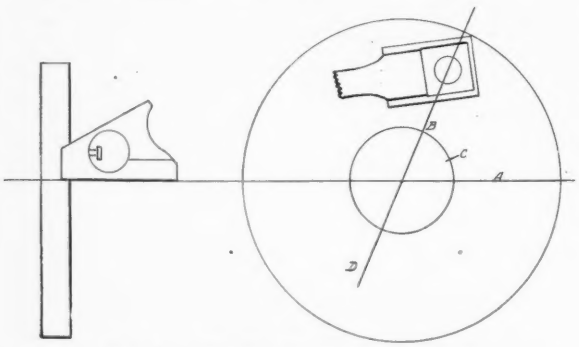


FIG. 1. ASSUMED POSITION OF CRANK

I will show the method I have used and proved to be accurate, where one man can do the work of a half dozen. Take for example a two-eccentric Corliss engine. In squaring, I will assume that the eccentric rod and hook rod are the right length. Have the steam valve wristplate central and the steam valve rods of such length

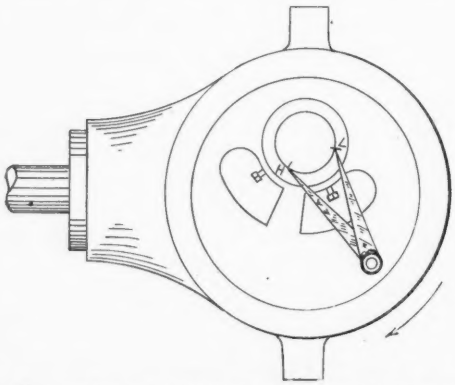


FIG. 2. REQUIRED MARKS ON ECCENTRIC AND SHAFT

that with both steam valves hooked on, each steam port will show open slightly less than half the port if a long range cutoff is desired or a cutoff beyond ½ stroke. Now move the wristplate to one extreme of travel so the center mark on the wristplate will come even with the outer extreme mark on the hub, and in this position make the dashpot rod just long enough to hook on and have 3/32 in. clearance. Do the same to the opposite end, and with the governor on the safety pin adjust the governor rods so that when the wristplate is rocked the valves will trip just before the wristplate reaches its extreme of travel. This is necessary on a long range two-eccentric engine, otherwise the steam valve would not positively close the port until the engine had passed the dead center and steam at boiler pressure would blow through the engine. Raise the governor to its racing limit and see that the valves do not pick up; if they do, change the governor rods until they don't. Now take out the safety pin and drop the governor to the lowest point, rock the wristplate by hand and see whether the valves pick up; if they do, change safeties until they don't. To set the exhaust valves, put the exhaust wristplate central and so adjust the rods that the setting mark on the valve will come even with the mark on the valve seat; this will make the exhaust valves come line and line; see Fig. 3. This is a large engine and it is assumed

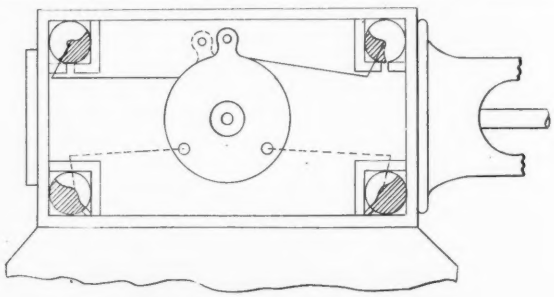


FIG. 3. CRITICAL VALVE POSITIONS

that it has stopped with the crank in the position shown in Fig. 1, or about ⅝ from the center.

The valves are now squared and the question is where to place the eccentric so that will be correct for the present position of the crank, Fig. 1. First connect the hook rod to the steam wristplate and shift the eccentric in its forward direction until the crank end steam valve comes to the edge of the port with a little lead, as shown in the upper right-hand steam valve, Fig. 3, leave this here for the present. Caliper the diameter of crank shaft and mark it on the crank at C, then draw a level line through its center at A, draw another center line through the crankpin and center of crank shaft, D. Make a mark on the eccentric near the shaft, also the shaft as at H, Fig. 2, then with the dividers take the distance from level line A to B where line D crosses the crank circle, C, Fig. 1, then go to the eccentric and put dividers on H and mark the shaft with the other end at L, Fig. 2. Now push the steam eccentric back until mark H on the eccentric comes opposite mark L on the shaft, Fig. 2.

The steam eccentric will now be in the correct position with respect to the crank and should be secured in

place. The exhaust eccentric may now be set. Referring to Fig. 4, draw the shaft circle on the face of the crank as in the previous case, draw a level line, A, through its center, then line B; then with a square placed at the center of shaft circle at E, draw line C at right angles to B. Set dividers to ¼ the diameter of the shaft and place them as shown in Fig. 4, and make a mark at D. With the exhaust wristplate central, and exhaust valves line and line, Fig. 3, after making the mark on exhaust eccentric at shaft, as previously shown at H and L on the steam eccentric and shaft, Fig. 2, (Fig. 4) step off the distance around the shaft circle from O to D; this will have to be stepped off with dividers and the number of steps added together and the distance around from O to D is the amount the exhaust eccentric will have to be advanced (starting with the exhaust wristplate in central position, exhaust valves line and line and the exhaust eccentric in the quarter position nearly 180 deg. ahead of the crank under the assumed conditions). The exhaust eccentric will now be in the proper position corresponding with the present position of crank, and everything will be all right, just as if the valves were set with engine on the center in the usual way of doing it; but the indicator is always proper at the finish.

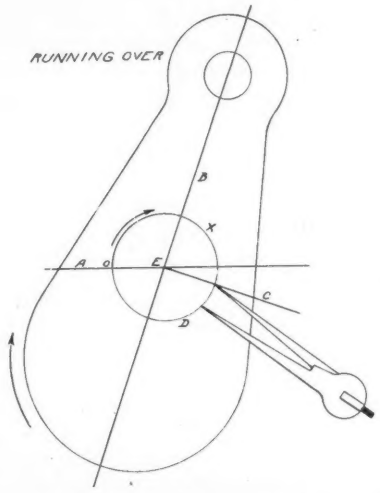


FIG. 4. MARKS FOR SETTING EXHAUST ECCENTRIC

A. C. WALDRON.

Special Field Coils on Alternator

SOME TIME AGO, a 250-kv.a. water wheel driven alternator was installed for a manufacturer to be used in operating a large number of three-phase induction motors. After the plant was placed in operation, it was found that many of the motors were very much underloaded most of the time, but could not be replaced by smaller ones on account of periodic peaks which occurred on the driven machines. As the average power demand was less than the capacity of the water wheel, more motors were gradually added until the wheel was practically loaded. At this time, it was noted that the generator was greatly overheating on account of the very low power factor of the induction motor load and it was evident that a burnout was liable to take place at any time.

Recommendations were made that the motor load be reduced by cutting off some of the machines, but the owner disliked to take this step on account of the enormous demand for his product and so the overload remained on the generator.

A little later, the field coils did burn out on the alternator; but inspection failed to disclose any damage to the stator windings, so an order was placed for a new set of fields. In the order it was specified that the coils be wound with 20 per cent more ampere turns to compensate for the power factor and make the fields as strong as the stator winding. The generator manufacturer at first demurred, but finally did make the coils as requested and they were placed in service.

Since that time, the machine has operated with perfect satisfaction and even with additional load. The excitation current has been decreased considerably and the exciter operates much better than formerly.

From the facts in this case, it would appear that when a given alternating current generator is to operate on a power factor much below 80 per cent, it would be well to have additional winding placed on the field coils at the time the machine is manufactured. A procedure of this kind might save many burnouts and much delay to the operator.

D. R. SHEARER.

Using the Slide Rule

THE ARTICLE of Mr. Wells in the Nov. 1 issue of Power Plant Engineering is interesting, as showing another man's idea how to solve that most puzzling problem that the slide-rule operator has to deal with, namely, the location of the decimal point. The writer has used a method or rule for several years that, to his way of thinking, is much more satisfactory, as it involves a minimum of mental effort.

The rule ordinarily given in books of instructions is not easily remembered. The first part is usually stated about as follows: In multiplication add the number of digits in the factors used, and in division subtract the number of digits in the divisor from the number of digits in the dividend to obtain the number in the quotient; when the slide extends to the right subtract one in multiplying, and add one when dividing. That may be perfectly simple, but for some reason, it is hard to remember. I have a rule that is so easily remembered that little effort is required to make the correction at the proper time. In fact, the mental effort is so small that after months of non-use I experience no trouble. Making the proper correction has become a habit, and as the number of digits is never large, it is easy to perform the additions and subtractions mentally as I make the various settings.

We remember things by associations, and the more unusual or paradoxical the associated idea is, the more easily it is remembered. The rule is stated as follows: If the slide extends to the left it is all right, but if the slide extends to the right it is all wrong. When it is all right, no correction is to be made; but when it is all wrong, the correction has to be made. The correction is as follows: In multiplication—that is, successive addition, use —1, and in division, which is successive subtraction, use +1. The mental effort to apply this rule, in my opinion, is less than that required to

perform the cancellation Mr. Wells uses. It has proven of value in teaching beginners to use the slide-rule.

Applied to the example that Mr. Wells uses, it works out as follows:

$$x = \frac{97.5 \times 815 \times 174.5 \times 0.755}{93.3 \times 22 \times 78.7 \times 3.455}$$

97.5×815, slide to the left, number of digits is $2 + 3 = 5$.

97.5×174.5, slide to left, number of digits is $5 + 3 = 8$.

97.5×0.755, slide to left, number of digits is $8 + 0 = 8$.

$97.5 \div 93.3$, slide to left, number of digits is $8 - 2 = 6$.

$97.5 \div 22$, slide to left, number of digits is $6 - 2 = 4$.

$97.5 \div 78.7$, slide to left, number of digits is $4 - 2 = 2$.

$97.5 \div 3.455$, slide to right, number of digits is $2 - 1 + 1 = 2$, or the number of digits to the left of the decimal point in the answer is two. Note that in this comparatively long problem the figures one has to deal with mentally are small.

I firmly believe that in the solution of problems in which it is not necessary to have the result closer than one-quarter of one per cent, that the slide rule is the most accurate means of solving, except the calculating machines, unless very careful checking is done. Calculating this problem by means of logs requires considerable time, and as there are eight logs to be taken from the tables and transcribed, two columns of six or seven figures to be added, a subtraction to be made, and then the number to be found, there are many chances for mistakes, and considerable mental effort is required.

I ran the foregoing example through once on a 10-in. slide-rule and obtained as a result 18.74, the last figure being estimated. My result was less than 11 parts in 10,000 in error, or approximately 1/10 of 1 per cent. That means that the accumulative error in all the settings was less than 0.005 in., or the difference between the logs of 18.74 and 18.76 plotted to a 10-in. scale, showing the accuracy that can be had with the so-called "guessing stick." I admit that this result is unusually close. READER.

Eliminating Exhaust Valve Rattle

ON PAGE 871 of the issue for Nov. 1, C. B. Hudson says "the only remedy for the rattling of the exhaust valves of a Corliss engine is a reduction of boiler pressure."

For more than 5 yr. a brother engineer operated a 14 by 42-in. Corliss directly across the street. From 7 a.m. until 4 p.m., his load was very light; hence, under ordinary conditions of operation, the exhaust valves were noisy. I do not know just what boiler pressure would give 16 lb. terminal pressure, but I think about 25 lb. by the gage. This was too low to be practical, as he must attend to other duties, hence it might easily get low enough to cause trouble. As the load was very steady, he made experiments to determine just how far to open his throttle valve to give a satisfactory terminal pressure, and having determined this, put a mark on the wheel and opened it to that point every morning. I have never seen a more quiet running engine than this simple operation secured. From 4 to 6:30 p.m. more load was on, hence he opened the throttle valve wide, carried the load all right, and still had a quiet running engine.

In my present engine room, there are three engines. During a small part of the day, the valves on one of them are rather noisy. If I should reduce the boiler pressure to meet this condition, the other engines could not be operated. Here it is not practical to reduce the boiler pressure, but the reason is not the same as for the previous case. The same conditions prevail in many other plants. In one of them a reducing valve was installed in the pipe line that supplies steam for an engine carrying a light load. The low pressure side was set for 40 lb., which gave the desired result without reducing the boiler pressure. Such a reducing valve should be located in a convenient place, with a stop valve between it and the boiler. Here are two cases where the desired reduction was secured without reducing the boiler pressure. W. H. WAKEMAN.

Shaft Slip

IT PLEASES ME to note that I have sprung "something new" on brother John Pierce when I write of shaft slip. Yet there is such a thing, especially where wooden pulleys are used, as pointed out by Mr. Pierce. I believe there is an enormous amount of power lost annually the world over, due to this little thing.

Even though a pulley does "holler" when it slips, it often is not recognized as shaft slip, but is believed to be belt slip. Thus when a load is suddenly thrown on, the belt may not slip at all, but the pulley on the shaft does, and in doing so it may or may not make a noise. On account of the great pressure acting on the shaft, however, the effect is clutch-like and the slip may endure for only a few seconds. Every time there is a sudden pull on the belt, though, there will be a little more slipping on the shaft. If it is a main drive, as I have pointed out before, each per cent of shaft slip costs the owner one per cent of the coal consumed plus the cost of lessened output.

I know of cases, too, where the slipping shaft made no noise whatever and where the slipping was practically constant. This is more liable to occur close to a bearing from which oil spatters onto or creeps along the shaft, thus lubricating the contact area between the pulley and the shaft.

Usually, where a pulley is loose enough to slip in this manner it slides lengthwise of the shaft and the belt runs off. The belt man then knows what is the matter without having to resort to any guesswork. But endwise slip does not always occur.

W. F. SCHAPHORST.

Valve Stem Packing

IN REFERENCE to J. H. Case's article regarding valve stem packing, I have used different kinds of metallic packing on Corliss valve stems, but at present am using a soft packing made and sold by the H. W. Johns-Manville Co., known as the J-M Kearsarge rod and valve stem packing No. 150, which can be had in spiral

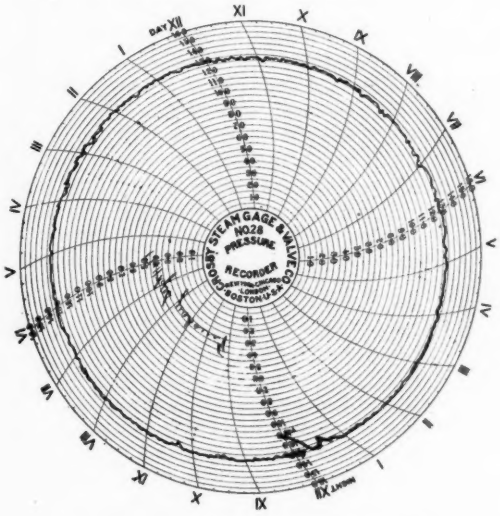
or cut rings. This is an asbestos rubber back well lubricated packing, and has given me no trouble.

When applied, it will last from 3 to 5 yr. without renewing, and apparently in good condition when removed at that time. This packing does not contract and let steam blow through when starting up. For piston rods I use the floating type of metallic which he mentions, but will add, apply to a new rod only, or smooth up the old one well or the packing will not last long.

G. H. W.

An Exceptional Pressure Record

I AM SENDING you a steam chart made by a 100-hp. horizontal tubular boiler serving a 75-hp. high-speed engine running at an average of ⅔ load for 24 hr. and a 12 by 7 by 12-in. steam pump running 24 hr. at 180 strokes per minute (rather high, but necessary) and a 45-hp. Corliss engine running 10 hr. of this time, besides a few small pumps, reboiler, etc.



A RECORD SHOWING CAREFUL FIRING

Our steam pumps are about 120 ft. away from the boilers and the steam line runs through an underground chase which at times condenses a considerable quantity of steam. The boiler is hand fired with coal averaging 12,600 B.t.u. per lb.

V. O. SAFRANEK.

Don't Quit Schooling

THE WORTHWHILE, progressive type of engineer continues to go to school; for him there is no completing of studies. He is required always to study, observe, and practice. When he ceases to study, he begins to get the habit of contentment and self-satisfaction.

Too many men have allowed themselves to become satisfied and content with their positions early in life. I always feel sorry when I meet a young man who is at a contented standstill in his profession, for I picture him to myself as a failure. Self-satisfaction stagnates the mind, and prevents one from seeing any of the better and newer things that would aid in advancing one's worth to himself and the world. It closes the avenue through which helpful improvements and learning would naturally come. If one continues too long in this mood, he becomes stunted in mental growth, and beyond aid of his fellow men.

Men whom we find in this state of mind are rutting the road of progress—they bar the progress of others for certain lengths of time. They are not giving to the world what they owe it.

There are many lucrative positions open and waiting for engineers who are energetic and masterful enough to keep on studying and increasing their store of knowledge. There is no need to quote here the many splendid examples of men who have by hard work and persistency made the most of themselves in the power plant field. You read of them and their achievements every day. It is sufficient to say that many of them were no better started or equipped in their early careers than thousands of our present-day young engineers.

Their success is the natural result of continuous schooling. When they no longer had the privilege of a tutor, they studied and schooled themselves. They never found an end to schooling—the greater their store of knowledge, the more they appreciated how much more was to be learned. No small portion of it came from operating practice, and mixing with better informed men of the profession.

Engineers should always endeavor to profit by personal contact. It is in their visits to each other's plants that a source of valuable information is accessible to those who are desirous of obtaining it.

In gathering experience and facts in this manner, they come first-hand, and should be the reliable kind, worked out in practice. The spirit of fellowship and cooperation is further strengthened by those visits where each swap their experiences, notes and data, and the personality of visitor and visited often serve to impress more vividly the talk, and make its memory more lasting.

Have you quit studying? Do you evade working out problems in your work? Are you disposed to give up too easily? Are you tending to drift into the self-satisfied, fair pay, stand-still job, or are you trying to go the other fellow one better by continuing your schooling?

CHAS. H. WILLEY.

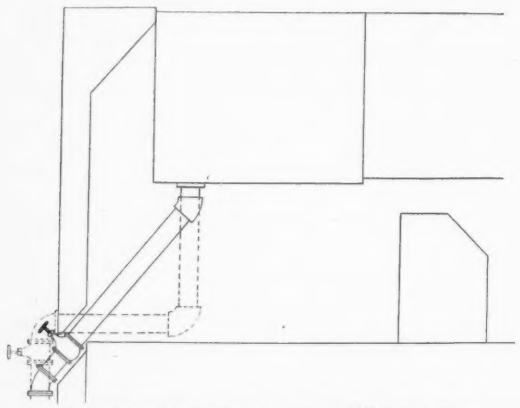
Don't Junk Old Valve Stems and Bonnets

IT IS my custom to save valve stems, bonnets, discs and disc retainers from old valves that have gone to the junk heap from some defect in the body beyond repairs. I have found that they are worth more to the company for making repairs than you could get for them as junk. For instance, when some inexperienced man will get a valve that won't shut off tight from some cause, the first thing he thinks of is to put a wrench on it. Anything from a 6 to 36-in. will answer his purpose. Usually the valve stem shears off flush with the packing nut, then comes a job for one of the mechanics. By having on hand an assortment of these secondhand valve parts, the repairs can be made with very little cost to the company, as the stem or both stem and bonnet can be replaced with one of these parts from an old valve of the same make, which oftentimes saves the company the expense of a new valve and the mechanic the time of taking down several feet of pipe to put on a new valve.

A. G. CROTHERS.

Improved Blowoff Connection

In a plant in a bad water section which the writer recently visited, he noticed an excellent blowoff connection, made as shown in heavy lines on the sketch. Upon investigation, it was found that the blowoff had originally been installed with the right-angle turns, as shown in broken lines on the sketch; but with this arrangement, trouble had been experienced because chunks of scale and clots of heavy mud would strike in the right-angle elbows and cause stoppage or partial clogging of the line. Because of this trouble, the right-angle turns were eliminated and in their place 45-deg. elbows were used, which made the blowoff connection shorter and more direct, and eliminated the turns which proved to be excellent places for the lodgement of scale particles. As will be noted, the change was also effected with practically no change in the exterior piping or brickwork. This arrangement might be followed to advantage by those located where heavy scale is formed and where trouble from clogged blowoff pipes is experienced.



BLOWOFF CONNECTION USING 45-DEG. ELS

M. A. Saller.

Trouble with High-Speed Engine

Much has been written about engine troubles and the cause of freak indicator diagrams, but one of the assistant engineers in our plant had an experience in locating the cause of a freak diagram that differs from any that I have seen described.

The engine, a 135-hp. balanced slide-valve high-speed machine, had been in service for a year or two, and it was decided to examine the valve seat and cylinder walls. The head and chest cover were removed and the examination made, and as the wearing surfaces appeared to be in good condition the head and chest cover were replaced without changing any adjustments. The engine was started up but did not seem to run properly, so the indicator was applied. The first card taken showed the crank end to be fairly good, but on the head end the admission pressure was only about ⅔ as high as on the crank end, and the exhaust pressure appeared to be about 30 lb. Several cards were taken with the same results. The steam chest cover was again taken off and the valve setting checked up and found to be correct, indicating that the trouble was not there. The eccentric and governor were gone over, without results, and the cause of the trouble still remained a mystery. As there was no apparent fault in the engine, the trouble might have been laid to the indicator; but as a last resort, the cylinder head was taken off again and it was discovered that it was put on wrong. The ports and clearance were of such design that the head was chamfered off on the side next to the steam chest, and in putting it on the first time, the head was accidentally turned one or two bolt holes so that the port was nearly closed off, preventing steam from getting in and out of the cylinder as rapidly as it should. In putting the head on the second time, it was marked, as it should have been in the first place to guard against such trouble.

The piston rod of this engine was put into the piston with a taper fit with a nut on the end of the rod fitting into a counterbore in the piston. The space around this nut was quite large, and was filled with babbit when the engine was erected in the shop.

Some time after the trouble with the head, a dull thud came on suddenly which appeared to be in the cylinder, and upon removing the head it was found that the babbit in the recess around the nut had broken in half, one-half falling down the cylinder, where it was flattened out into the clearance space. The wonder was that it did not break the piston or cylinder head, but fortunately it did not. The question then arose, "Why was the babbit put in that space?" It could not prevent the nut from turning if it had become loose, as the counterbore was round and smooth. In talking with an erecting man some time after this occurred, he suggested that probably the engine had some trouble in meeting the water rate on the testing floor, as it was low for this type of engine, and that the babbit was put in to fill up space and reduce the clearance volume. Whether or not this was the true reason I do not know, but it sounds quite plausible. The space was not refilled, as it was considered dangerous, although it might not have happened again in many years, and no difference can be seen in the running of the engine.

J. C. Hawkins.

Answering an Ad

For the past few years, I have noticed that engineers, in advertising for a position, are not as keen as they used to be about owning their own indicators. Maybe the indicator, as a dazzler and hypnotizer of bosses and future bosses, has had its day. I don't know because I never owned one. I always figured that if the man who owned the engine and bought the coal couldn't afford one, I couldn't either. It seems to me that it would be more beneficial to an engineer and his family if he owned a typewriter and spent his spare time on that rather than on an indicator.

A few years ago, I took the place of a fairly good engineer who was getting $1800 a year and his board. He owned an indicator. He stayed with me a week before his month was up and I learned that he had no job in view. I saw a good-looking ad in an engineering paper, and calling his attention to it, asked him why he didn't answer it.

He said: "Well, I'll tell you; I haven't enough faith in my ability to write—they wouldn't answer my letter."

He had evidently had experience. You may say that it isn't a novelist they want in their engine room; that is true, but the man who eventually lands the job is the one who makes the best impression first. This is so true that it seems unnecessary to say it; but it is surprising the number of engineers, or so-called engineers, who do not know it or who do not give it a thought. I have had considerable experience answering ads and, after looking over past performances, I think I could almost qualify as an expert answerer. In 5 yr. I have had seven jobs in seven plants, in charge of four of them, and every job a step in advance financially. I have never failed to get an answer and seldom failed to get the job if I wanted it. My batting average is very high. I may not have had as much experience as some engineers, but in writing to a prospective customer or employer I utilize every single bit of it and it spreads out and makes quite a showing, just as a man running a store displays his goods in his show window. You don't blame him for that; you would call him a fool if he didn't. Your application is your show window and it is up to you to display that which you have to sell in the most attractive manner you possibly can.

I don't advocate changing positions often, but I believe that if a man has something to sell he should keep himself posted on the market conditions the same as a farmer subscribing to a weekly stock report to keep posted on the price of hogs. It's the same thing. I don't believe any farmer would continue to sell his hogs to one firm just for old times' sake if he could find some firm that would pay more.

In the last few years, I have had some experience on the other end of the want ad game—the employer's end. I have written the ads and received the answers, and as a form of amusement I can highly recommend it. An ad said: "Wanted—To get in touch with a first-class engineer, one who desires a position in a large establishment operating a heating and electric lighting plant. Must be single and board and lodge on premises. Give full particulars, age, experience, references, etc."

I got about sixty answers and only two obeyed to the letter the first order from their prospective employer. Only two gave full particulars and references and described fully the plants they had worked in. The plants you have worked in count as much, if not more, than the references. Anyone knows that a man would not give the name of a former employer who might give him a bad recommendation.

It is all right to toot your own horn, but not loud like this: "If you are looking for a thoroughly competent man that knows his business in power station economy and the directing of men, I fill the bill conclusively." He didn't give any references. He didn't describe the plants he had worked in or the positions he had held. He never got down to earth. He wasn't going to let us judge his ability from his experience. He was satisfied that he was the man for the job and I suppose we were to take his word for it. He doesn't know why we didn't answer his letter. He wrote a very indignant letter asking why we had not replied.

Never request an answer from a blind ad. Do your part and the advertiser will do his. Do exactly as the ad says and if you have had the required experience, the advertiser will recognize it. The object of a blind ad is to do away with the annoyance of seeing and turning down a lot of undesirables. Don't write and say you "can give references"—give them if you can—that is your first chance to make an impression and probably your last unless you make a good one. Don't hope for a personal interview. Write a good letter and you will get the interview. The letter is the big thing and the thing that counts. You tend to the letter and they will do the rest. That is their business.

One fellow said: "Do not use tobacco nor liquor, neither drugs"; another, "I am not married nor do I use tobacco or booze." He evidently classes marriage along with other obnoxious habits, forgetting, perhaps, that the man he is writing to may be married and use both tobacco and booze. I neither drink nor smoke, but I don't tell people about it when I apply for work unless they ask. I never saw a want ad that required anyone to state whether they used tobacco in any form, but I seldom see a reply that doesn't make that the main issue. Don't waste any time or space in telling what you don't do. Tell what you do and what you have done.

Here is another horrible example: "In answer to your ad, would like to have a chance to try the job. Have had 10 yr. experience with steam engines and heating plants, not so much, but understand boilers and their care and also two winters and one summer with a lighting plant."

Don't say that you have had experience with all kinds of heating systems or engines and let it go at that. Anyone can say that. Name the kinds you have worked with and prove that you do remember the names of them at least. Write about them so that an engineer reading your letter would know whether you had been through the mill or not. Call a lighting system by its name—a "110-v. 60-cycle a.c." or "3-wire 220-v. d.c." If you have worked on a heating system, you certainly know whether it was a "one-pipe gravity" or a "two-pipe vacuum." Tell about it in your first letter—your introduction to your future boss maybe—so he can form his own opinion as to whether you can handle the job or not. It is his opinion that is going to settle the matter and not the fact that you think you are the man for the job. Make him think so. Prove it to him; telling him that you are perfect isn't proving it. Talking machinery and positions with names and dates is proving to him that you are not an absolute stranger to an engine and that is about all you can do. That's the thing—do all you can. That's what a man wants you to do after he has hired you and before he hires you it is up to you to give him a free exhibition of yourself going at full speed doing all you can. Make him think it is a regular habit of yours. When he asks in his ad for full particulars, experience, references, etc., don't reply with a brief letter stating that you have had experience with all kinds of boilers and engines and do not smoke nor drink. If this is the kind of letter you write, it quickly finds its way into the waste basket, along with others that have made no impression, and goes down to help heat the same boilers you thought you could run.

F. R. Daly.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Poor Ammonia Circulation

I HAVE a 25-ton refrigeration plant in which the mysterious disappearance of ammonia cannot be accounted for.

Last winter, the plant was overhauled for this trouble by an expert and a complete new charge put into the system. A few months later, the receiver could not be made to show any liquid at all. After charging 350 lb. into the system without results, I heated the condensing coils with burning waste and shortly my receiver was filled; but the next day, my charge disappeared again and I had to repeat the operation to get it down and could not keep it in circulation until I cut out two of my five stands of condensing coils. My charge worked well for a couple of months and then gradually disappeared again. Since then, I have charged 500 lb. at intervals into the system with only a temporary effect. I have pumped down the condensers while under a temperature which I produced by pumping boiling water over the coils in order to facilitate the movement of the ammonia and have pumped the coils completely empty and still find no trace of the ammonia.

When I pump down the expansion coils, the back pressure does not gradually rise again, which leads me to suppose that the ammonia is not trapped in the expansion coils.

Kindly tell me if the ammonia could be trapped in the expansion coils and not show on the back pressure gage. If so, how could I remove it from there?

My condensing coils are made of galvanized pipe and probably this may produce an effect on the ammonia. Please tell me what effect, if any, it produces on the ammonia. My plant has as few leaks as any I have seen, so I cannot account for the loss of ammonia. Kindly advise me what I should do or what the trouble is.

Would you advise the installation of an ammonia purifier? V. O. S.

A. The real cause of the trouble is the galvanized coils of the ammonia condenser, provided that the pipe is galvanized on the inside as well as on the outside. Ammonia acts on the zinc and the result is a very fine dust which looks like dry cement. If oil is allowed to enter the system, this dry dust becomes a gum-like mass and will lodge in places and stop the circulation of the ammonia.

Most likely such blocking will be found at the outlet valves of the condenser coils. The best thing to do is to pump out one stand of the condenser at a time and disconnect both inlet and outlet. Make air and steam connections so that the coil can be blown out with both. First use the air. If the coils are galvanized on the inside a cloud of white dust will be blown out. If steam is used first, the condensation will wet this dust and cause it to cling to the pipe and no amount of blowing will loosen it till it becomes dry.

After using the air, next use steam and let the steam blow through till it comes out dry as possible. Then while the coil is still hot, blow with air again till the outlet end of the coil shows perfectly dry.

If it is true that the condenser coils are galvanized on the inside, this blowing out with air will have to be done about once a month to remove the zinc as it becomes loose. Steam is not necessary unless the coils are coated with oil.

This winter, blow the entire system with air, steam and air. This thorough cleaning may stop the action caused by the combining of ammonia and zinc. If the eating continues, the only remedy is to take out every piece of galvanized pipe and replace with black pipe.

The eating action of ammonia on anything galvanized can be plainly seen in the case of a leaking coil in an ice tank. The galvanizing will come off the ice cans and in time the cans will begin to pit and leak.

If there is no relief gas line between the top of the liquid receiver and the top of the condenser, one should be put in; relieving the light gas from above the ammonia in the receiver will help the circulation greatly.

An ammonia purifier is a great advantage to any refrigerating plant; for, by its use, the impurities can be drawn off and the ammonia kept in a pure and dry state such as is necessary to good results.

Examine the inside surfaces of the condenser pipe for pitting, as the eating action may have begun on the iron. If it has begun, new condensers will be necessary.

A. G. SOLOMON.

Advantages of the Uniflow Engine

KINDLY INFORM ME of some of the advantages to be realized from the use of a uniflow steam engine.

C. O. H.

A. As to the advantage of the Uniflow engine, the general explanation is, that the steam exhausting from the middle of the cylinder through the port which is uncovered by the piston at the end of the stroke, does not pass back over the surfaces of the cylinder at low pressure, and therefore does not take up heat from those surfaces before being exhausted. On its return stroke, the piston covers this exhaust port and begins practically at once the compression of the steam remaining in the cylinder to a higher pressure, coming up practically to initial pressure by the time new steam is admitted. In this way, there is less cooling of the cylinder walls, and therefore less condensation of fresh steam as it is admitted.

In addition to this, there are two factors which, in the opinion of the writer, have a very large influence.

One is, that the Uniflow engine is, as a rule, made with a comparatively long stroke and small bore. Experiments in the past have shown that this condition tends to help in the reduction of cylinder condensation in any type of engine; also, the piston runs at a high speed, which gives less time for the transmission of heat between the steam and cylinder walls than where the piston speed is slow.

A fourth factor is the steam-jacketing of the cylinder heads and the ends of the cylinders. Some 25 yr. ago, steam-jacketing was largely advocated for the entire barrel of the cylinder as well as for the heads, and was found to help considerably in reducing the condensation of the entering steam. The method was not widely adopted, however, as the use of the compound engine became common, and this accomplished the same purpose, to better advantage, than the jacketing. No very definite comparative tests have been made of the Uniflow engine with and without the use of steam jackets, but we believe it is conceded that the jacketing has a large influence in producing low steam consumption.

The mechanical advantage which the usual design of Uniflow engine has, is the ability to run at a high number of revolutions per minute, because of the use of a positively driven valve gear. The Corliss engine, because of the disconnecting mechanism, cannot run at more than 150 r.p.m., while the Uniflow may be run at any speed available for a slide valve or high speed engine. This results in high piston speed, with the advantage already mentioned, and also permits of a smaller cylinder volume for a given horsepower.

A. L. R.

Setting Piston Valves

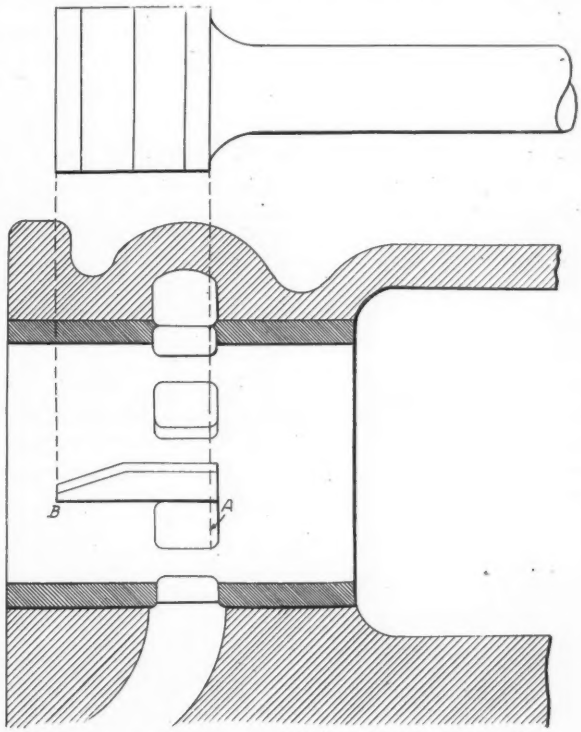
KINDLY TELL ME how to set piston valve which takes steam in the center. I. M. C.

A. The eccentric should be placed on dead center next to the cylinder and scribe a mark on the valve stem and guide, which mark can be made to return the parts to their original position should occasion require to make a fresh start, which would otherwise be found difficult when the edges of the valve and steam ports cannot be seen easily. After marking the original position of the valve gear, disconnect the valve stem from the guide block, take off the back steam chest cover, pull out the valve and stem and remove the other check cover; make a templet of thin sheet iron about an inch wide and about as long as the thickness of one end of the pistons of the valve plus the lead.

Place the templet against the inner side of the head and port A, as shown in the accompanying illustration, and with a scriber make a fine mark on the other end of the templet, B. In case the valve pistons are both of the same length, repeat the operation at the opposite end of the chest, using the same templet. If, however, as sometimes happens, the valve piston on the crank end of the chest is of a different length, a new templet must be made for locating the valve on this end of the chest. Now, place the valve in the chest and connect up the valve gear to its original position.

It will be observed that the effect of admitting steam to the inside of a piston valve, or between the valve pistons, is the same as adding a rocker shaft to the valve gear of a slide valve engine, as the valve travel is opposite that of the piston when the latter is at or near the dead center; therefore, after placing the crank on the dead center nearest the cylinder, turn the eccentric on the shaft in the opposite direction to that in which the engine is to run until the outer end or edge of the valve just coincides with the fine line, B, drawn on the valve seat farthest from the crank. The inner edge of that piston of the valve will then open the steam ports to the amount of the lead. Fix the eccentric to the shaft and turn the crank to the opposite dead center, when the outer edge of the valve at the opposite end of the crank should coincide with the line drawn on the valve seat.

If it does, then the inner edge of that piston of the valve also opens the steam port to the amount of the



METHOD OF LOCATING VALVE BY MEANS OF TEMPLET

lead and the valve will have been correctly set. Any difference between the leads on the two ends may be equalized by adjusting the valve stem at the guide block and the setting of the valves should, if possible, be verified with the indicator. W. P.

Induction Motor Operated As Generator

ASSUMING POWER were applied to drive an ordinary induction motor, at what point in its speed would it become a generator? Or would it become a generator? If not, what would be the necessary conditions in order to make it a generator? T. H. C.

A. If a polyphase induction motor, while running light, and still connected to its supply circuit, be mechanically driven above synchronism, the slip will be negative, the secondary conductors will cut the revolving flux in the opposite direction, the secondary electro-

motive force and current will reverse with respect to the flux, and the torque reaction of the secondary current will oppose the rotation. This means mechanical power absorbed and a reversal of the direction of power flow across the air gap—that is, generator action.

The usual arrangement for excitation is to operate induction generators in parallel with one or more synchronous machines, motors or generators, usually the latter. The synchronous machines supply not only their own excitation, but also that for the induction generator as well as the quadrature or reaction current demanded by the secondary apparatus connected to the system.

When excited from synchronous machines, the induction generator has no inherent regulation as to voltage, since in this respect it is quite as passive as an induction motor and depends wholly upon the voltage and corresponding excitation supplied to it by the system. In other words, the voltage must be controlled by the excitation of the synchronous machines connected to the system. O. H. H.

A Good Boiler Room Paint; Removing Scale

Will you give me a formula for an inexpensive paint suitable for the inside of a boiler room?

2. Kindly tell me of some good scale softener or remover. The scale is exceedingly hard and although I have used the turbine in it, it does not come off very readily. G. L. L.

Answers

For a water paint, the best thing is probably a whitewash which can be tinted to any color you wish. The formula used by the United States Government is as follows:

Unslaked lime	2 pecks
Common salt	1 peck
Rice flour	3 lb.
Spanish whiting	½ lb.
Clean, white glue	1 lb.

Slake the lime in a vessel of about 10 gal. capacity; cover it, strain, and add the salt which has been dissolved in warm water. Boil the rice flour in water; soak the glue in water and dissolve on a water bath, and add both, together with the whiting and 5 gal. of hot water, to the mixture, stirring all well together. Cover to protect from dirt, and let stand for a few days. It is to be applied hot, from a kettle over a portable furnace.

If a tint is desired, it can be had by adding any of the dry colors, in quantity to give the desired tint.

For ordinary whitewash, take 12 lb. of whiting, in large balls, break them up in a pail, and cover with water to soak. Melt over a slow fire, 4 lb. of common sizing, and with a palette knife or trowel, rub up fine about a dessert spoonful of blue-black with water to a fine paste. Pour the water off the top of the whiting and stir in the black. When well mixed, stir in the melted size and strain. Allow to stand until it is cold, and then use. If too stiff, beat up well and add a little cold water. This gives a heavy wash which spreads well on a smooth surface, but will probably streak somewhat on brickwork. The streaking effect can, however, be remedied by thinning down with cold water until the wash will work smoothly.

2. As to the scale in your boiler, it is difficult to predict what will remove this without knowing what forms the scale. Probably a strong solution of soda ash will loosen it. If this is not effective, a solution of caustic soda may work. If neither of these will dissolve the scale, it will probably be necessary to have a chemical analysis to find out what composes the scale, and then a chemical which will react on the scale material must be used.

You can try this out by scraping off some of the scale and boiling it, first, in a strong soda-ash solution to see if it dissolves; if not, boil some of it with a strong caustic-soda solution. Do not get your solutions so strong that there will be any of the soda ash or caustic soda particles in the solution.

If neither of these solutions will dissolve the scale, it will be necessary to take a sample to a chemist for analysis. One of the Government departments, presumably the Bureau of Mines in Washington, would be able to give you this assistance. A. L. R.

Oil in Gas Engine Cylinder

Referring to the troubles of C. E. N., on page 871, of the Nov. 1 issue. I would suggest the following:

Take off the cylinders and fit a solid sheet of copper about 1/64 in. thick, between cylinders and crank case; cut out a slot just large enough to allow piston rod to move freely and bolt cylinders in place with a very thin gasket on each side of copper sheet. This sheet or shield acts as an oil-guard or baffle, allowing only enough oil to pass through around the piston rod to lubricate the cylinder walls. This method is employed in a number of automobile engines and is not new.

I presume that "three-cycle" should be three-cylinder and that the engine is a two-cycle; should it, however, be a four-cycle engine, it might help some either to enlarge the breather or install an additional one to relieve the pressure in crank case, which may have something to do with increased oil consumption.

Karl H. Mueller.

I have been through the trouble experienced in connection with oil passing rings on the piston. New rings will not be a certain remedy.

The trouble may be due to the fact that the joint of the new rings is not closed tight. Assuming that the piston on the engine in question was of the usual design, consisting of three power rings at the top and a wiper ring at the bottom, I would suggest that we have a groove turned in the piston between the wiper and top rings and drill six holes about ⅛ in. in diameter connecting the groove to the interior of the piston. This groove would serve as a wiper and the holes will deliver the oil passing the bottom ring into the center of the piston.

I had this arrangement applied to a piston where oil accumulated in such quantities on the plug as seriously to interfere with the engine operation, and it resulted in a dry plug. W. O. Moody.

REPLYING to C. E. N.'s letter, I would suggest reboring the cylinders and using an over-size piston fitted with leak-proof rings.

I have cured an engine in this way of similar trouble. The engine had been fitted with new rings a number of times without any benefit whatever, the cylinders having become worn out round. G. H. W.

WITH REGARD to inquiry entitled, Can You Suggest a Remedy? I offer the following: I am of the opinion that not only is C. E. N.'s cylinder worn "out of true," but probably he is not using the best form of piston rings that can be obtained. The ordinary split, spring ring, no matter how carefully made and fitted at first, is not leak-proof. Even if that type of ring were leak-proof at first it will not remain so for any appreciable time. If the cylinder is worn "out of true"—and it is likely that it is—new rings will not stop the leakage complained of. Therefore, he must get his cylinder rebored or reground, and then have the piston fitted with either a two-piece or a three-piece piston ring, such as are employed in automobile gasoline engines. If C. E. N. will do this, and have it done correctly, he will have no further trouble on the score complained of, for years to come. CHARLES J. MASON.

IN ORDER to remedy trouble I once experienced similar to that related by C. E. N., I rebored the cylinder and replaced the old rings with new ones of a closer fit. C. C. W.

Why the Cracked Blowoff Elbow?

IN THE sketch, I have endeavored to give a rough idea of one of three blowoff connections which are constantly giving trouble by cracks in the elbow, always at the same place. No matter what strength elbow we use, we find them cracked just the same, on the upper side of the lower run of the elbow, as shown in the sketch.

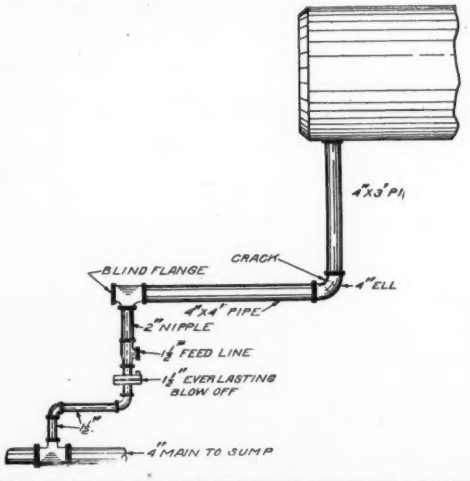


DIAGRAM OF BLOWOFF CONNECTIONS SHOWING LOCATION OF TROUBLESOME ELBOW

We use induced draft and carry 120 lb. steam. The boiler is 60 in. by 16 ft. with ⅜-in. shell and ½-in. heads. The feed-water temperature ranges all the way from 130 to 212 deg. F. There is a V-shaped brick pier built in front of the blowoff, leaving no clearance between pier and shell. I would like to have the views of engineers as to the real cause of this trouble. The blowoff is never covered, owing to frequency of inspection. The last elbow we put on was of special steel made by Crane Bros. H. B.

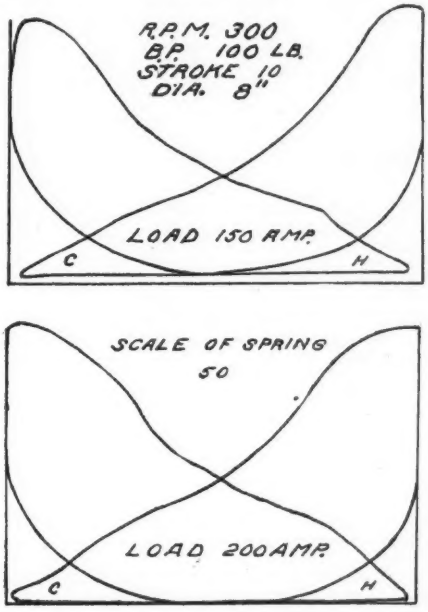
Using the Hammer Test

IT IS INDEED regrettable that conditions such as related by R. B. on page 829 of the Oct. 15 issue of Power Plant Engineering are allowed to exist.

If I were engineer in that plant, I would cut out one boiler at a time for washing and inspection, using the hammer test on the tubes in such a manner that it would be impossible to refill the boiler. Then report conditions to the firm and observe results. Continue with the second boiler in a like manner until through with the job. G. W.

Card Criticism Desired

THE ACCOMPANYING indicator cards are from one of our engines and I should like some of the readers of



DIAGRAMS FOR CRITICISM

Power Plant Engineer to say what they think of the engine and the work done in each case. J. W. P.

A COMPANY in England wishes to secure the agency for or buy outright ceiling fans of 220 volts, using 180 to 200 watts, having 4 wooden blades with 56 to 58-in. sweep, with hanger and canopy, but without down rods; also 220-volt desk fans, 16 in. in diameter, and 5-point fan regulators for 220-volt circuits; also electric lamps of 5 to 50 candlepower, 110 and 220 volts; bracket electric fans and one-half watt lamps. Quotations should be made f.o.b. New York, with terms cash in New York against shipping documents. Further particulars may be had by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., and asking for information on 25,854.

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Nothing Too Small to Count

Someone has said lately that modern warfare is waged by whole nations and not by armies alone. This is the situation today as never before. Scientific methods of fighting and the enormous size of the forces engaged have brought this about. It follows that every individual can take part, no matter how humble his place, and this is one of the glorious features of this war for democracy which in some measure offsets its evils. It all comes down to a realization that nothing is too small to count in the grand total effort against our enemies. Sometimes the engineer or fireman engaged in necessary and important duty at home gets discouraged because his task is performed so far out of sight of the world. The institution of little economies around the station seems a petty accomplishment. But are not such duties performed perforce under the station flag, and how many of us realize the immense amount of wearisome waiting and humdrum training involved even in preparation for the active duties at the front itself?

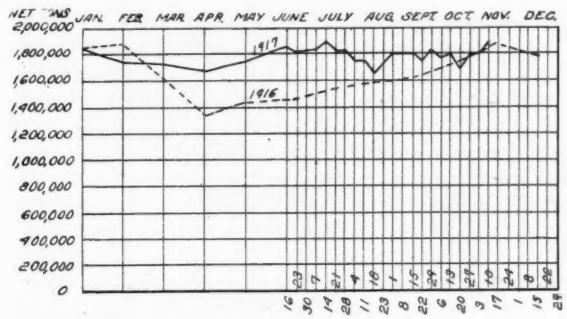
Let us use our imaginations a little and think what even petty economies amount to when multiplied by the patriotic work of others in similar lines. To cut off a 25-watt lamp from burning over one's desk for an hour or two when not needed looks at first blush like a ridiculous step toward helping win the war, but it easily means the saving of an ounce or thereabouts in the coal consumption. Granted that this small amount never could be found in the station record, it none the less follows that such economies multiplied over a wide area soon run into the tons; and tons are what are needed to furnish coal-burning steamships with the means of crossing the ocean and delivering men and munitions to the battle front. Thus there is a connection between the fireman's shovel and the first-line trench none the less real because it is invisible! Is not this an incentive to do one's best in the daily routine which has its bearing upon the great cause of liberty? He who stops a steam leak, who reduces the power consumption of a coal conveyor by improving its lubrication, who stops the running of heavier units immediately after lighter ones will handle the load more efficiently, who analyzes his station heat losses more thoroughly this winter than last, and who makes a 10 or 15-watt lamp perform the service which a 25-watt or a 40-watt unit needlessly cared for previously may think these acts are insignificant in relation to the work which fills the daily press; but it is not so! Of course, there are degrees of sacrifice required; but, as was pointed out above, every single one of us can help and thanks be that this is so!

Sign Lights Out

The country is at present on the verge of a coal famine, many cities are now controlling deliveries to residences and industries. Although the report compiled by the United States Geological Survey for the week ending Nov. 17, from which the accompanying chart was taken, shows an increasing output, this production is but slightly better than last year and the demand for coal has greatly increased owing to increased industrial, transportation and shipping activities due to our entrance into the war. There is, moreover, no

assurance that this output will be increased as it should be, for labor conditions are still uncertain and many engaged in mining have been taken for our armies. The principal cause of loss in production is reported as car shortage, which ranges all the way up to 40 per cent of the mine's capacity in some cases. It is apparent, therefore, that the efforts of those controlling the selection of coal for industrial purposes be directed toward adapting their plants to use fuel mined nearest at hand and release cars as quickly as possible.

At the consumer's end of the power plant many economies may be effected in the use of power as has been noted in the preceding article. There are in addition to these small savings many non-productive and non-essential uses of power which should be stopped immediately and discontinued at least during the period of fuel shortage. One of the most extensive of these uses is for illuminated advertising signs. This class of service has been a profitable line for central stations which have made attractive inducements to customers, and naturally the service has grown broader and the signs more elaborate and extravagant in the use of power until today a single one of many of these signs consumes more power than a whole community of residences.



ESTIMATED TOTAL DAILY AVERAGE BITUMINOUS COAL PRODUCTION

Under present conditions an order, prohibiting the burning of coal for generating electricity for use in illuminated advertising signs, from the government fuel administrator is welcomed by all who have the country's interests at heart. The essential features of this order which went into effect Nov. 15, follow:

No power plant shall use coal for the purpose of generating electricity to be used in lighting, maintaining or operating, before the hour of 7:45 p. m. or after the hour of 11 p. m., electrically illuminated or display advertisements, notices, announcements, signs, designation of the location of an office or place of business, or of the nature of any business, electric search lights, or external illumination of buildings, except in such special cases as: Signs maintained by the government of the United States, any state or city. Street lights of cities or towns. Electric signs affixed to the street fronts of buildings over the street entrances or over the street entrances to stores, shops, or other places of business, or extending over the sidewalks, for the purpose of announcing the name or business of a retail shop or store, or the name and location of a theater or other place of amusement or of a hall or other place of public assembly, together with the name of the play or other entertainment, or of the purpose of any public assembly to be held. Such signs may be lighted or illuminated or operated by electricity, generated or produced by the use of coal, from one-half hour after sunset until such time, not later than 11 o'clock in the evening, as the business is closed for the conduct of business in the same manner and to the extent that such business is conducted during the daytime business hours, and in the case of places of amusement and public assembly until one-half hour after the time fixed for the beginning of an entertainment or of the meeting of other public assembly, as the case may be; Provided, That the size of any such sign and the amount of electricity needed to operate and illuminate it shall be reduced at any time upon direction of the State fuel administrator of the State within which such sign is located.

This order does not apply to porch lights upon houses or hotels or at the entrances to buildings occupied or open for ingress or egress during the nighttime, or to lights upon private driveways, walks, or in the grounds of any hotel, manufacturing establishment, or residence, or upon the platform of railroad stations, approaches thereto, or in railroad yards or grounds, or to lights to mark the location of fire escapes or exits; or to lights for any similar purposes when authorized by any State fuel administrator of the State within which such lights are located: Provided, however, That the number and power of any such lights, by this paragraph permitted, shall be reduced at any time upon direction of the State fuel administrator of the State within which such buildings or grounds are located.

State fuel administrators within the several States are directed and authorized to see that the provisions of this order are observed and carried out within their several States, to report violations thereof to the United States Fuel Administrator, and to recommend to the United States Fuel Administrator action to be taken by him with respect to the sale, shipment, distribution, and apportionment, partnerships, or persons found to be acting in violation of this order.

Service Overseas

ENGINEERS are wanted for early service overseas. The men in the front line trench need the help and co-operation of skilled men back of the lines, and steam engineers and firemen are wanted at once for the Enlisted Ordnance Corps, National Army.

Uncle Sam is calling on our trade to come across and help his fighting men. There is a lot of work to be done over there, and the call has gone out for skilled men of all trades between the ages of 18 and 40 who want to do their bit, and who know their job.

Modern war is a tremendous business, and the army that wins is the army which has the best equipment and the best men. The men are over there now; they are ready to go ahead, but they still need experts in our line to repair and maintain their equipment. There is a fine chance for every man who wants to help. Write to the Chief of Ordnance, War Department, Washington, D. C.

THE PREVENTION of smoke may be more easily accomplished when the coking method of firing is employed than when the alternate-spreading method is used.—Technical Paper 34, Bureau of Mines.

Power Apparatus in Shop and Market

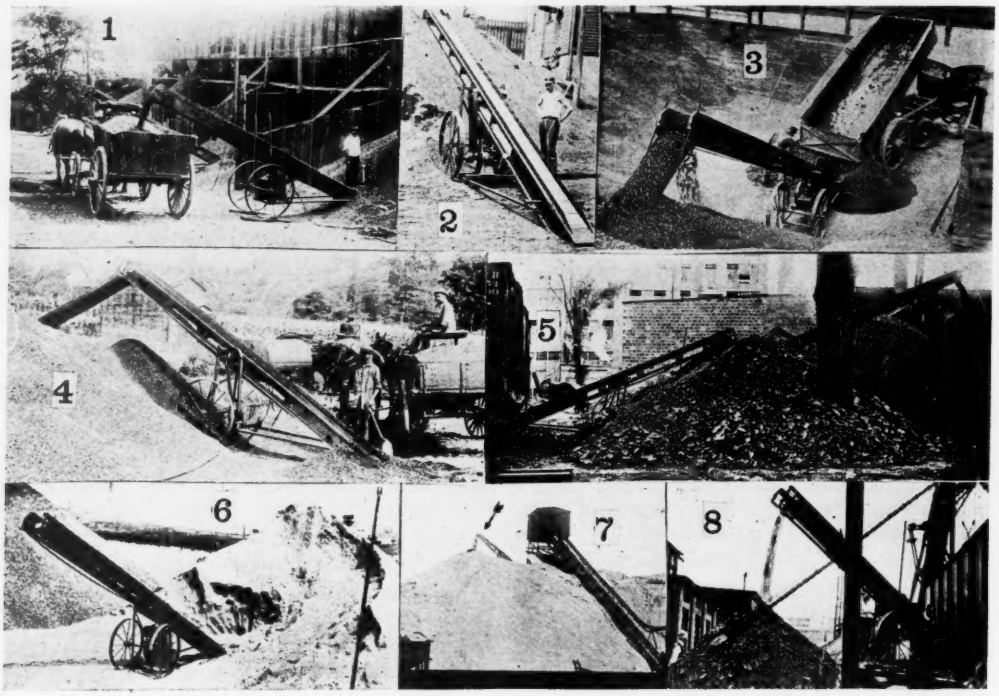
New Ideas In Making, Buying and Selling

Portable Scoop Conveyer

A NEW TYPE of portable belt conveyor which has found a ready market is manufactured by the Portable Machinery Co., Inc., of Passaic, N. J.

The machine is operated either by electric motor or gasoline engine and is known as the Scoop conveyor because the conveying belt receives its material through a scoop which can be pushed or completely buried into the material to be conveyed.

The object of the scoop conveyor is to provide a portable machine that can be readily handled by one man for the purpose of loading and unloading, stacking and reclaiming loose materials such as coal, coke, ashes, crushed stone, sand, gravel, etc.



VARIOUS APPLICATIONS OF THE PORTABLE SCOOP CONVEYOR

From the accompanying illustrations it will be noted that the scoop conveyor has an unusually wide range of application.

The manufacturers claim that it will also handle sacks, packages, boxes and various manufactured products and that one man and the scoop conveyor will handle loose materials at the rate of one ton in 1½ min.

Keeping cars and trucks moving and cutting cost of hand shoveling is a necessity under present day operating conditions.

Heat Insulation

IN THE saving of fuel, which is now a patriotic duty as well as an economic necessity, insulating materials are an important factor, particularly where high temperatures are involved, as in the case of boiler and other furnaces. It is important, in using such material, to get that which has the best insulating properties and also has durability.

One form of such material, which on test has shown valuable attributes, is Sil-o-cel, which is a material obtained from natural beds in California, the material being a mineral known in its crude form as Celite, having a large proportion of silicon and composed of numerous hollow cells. The weight is light, 25 to 30 lb. per cubic foot, and when ground the weight of the powder is 8 lb. per cubic foot. Tests have shown that it has an insulating power of 9 to 12 times ordinary fire brick, the melting point is high, 2930 deg. F. or 1610 deg. C.

Bricks and blocks of various sizes and shapes are prepared by sawing the natural material, the standard 9-in. brick weighing 1½ to 2 lb. each and having a crushing strength of over 400 lb. per square inch. The method advised for the use of this insulation is to put

it outside the fire brick lining, carrying long bonding bricks from this lining through the insulating brick layer into the red-brick, outside wall. If preferred, metal wall ties may be used instead of the bonding brick. Where a wall is already built of fire brick and red brick, it is possible to put on the outside of the wall a metal-lath and cement casing, filling the space between this casing and the brick with the Sil-o-cel powder, or a sheet metal casing may be used tied into the brick wall with a layer of the powder between the casing and wall.

A striking experiment which shows the insulating properties of this material is that a brick of Sil-o-cel may be held in the hand flatwise while a gasoline torch flame is applied on the side opposite the hand without burning the hand or causing inconvenience.

The brick is laid with the thinnest possible joint of Sil-o-cel mortar which is furnished by the makers of the brick, and is composed of 80 per cent of the Sil-o-cel powder and 20 per cent slaked lime. This is mixed with sufficient water to produce a thin body into which the brick is dipped before laying.

The Sil-o-cel products are produced by the Celite Products Co., of New York City, and have been widely used for insulating boiler settings, kilns, electric furnaces, gas producers and for pipe covering. It is also an effective fire-proofing material for buildings, and a valuable sound-deadening material for floors, walls and ceilings.

News Notes

SUBSCRIPTIONS to the Second Liberty Loan, made by the employes of the principal plants of the Link-Belt Co. and by the company itself, amounting to $269,000, were divided as follows: Indianapolis plants, $104,300; Philadelphia plant, $71,300; Chicago plant, $61,100; Link-Belt Co., $32,300; total, $269,000.

THE COMBUSTION ENGINEERING CORPORATION is represented in the various branches of the National Service, insofar as its drafting room is concerned, by six men who are enrolled in various units, as follows: Hugh Campbell, National Army, Camp Upton; Robert Weber, Naval Reserves, 3rd District; Hubert Ahearn, Naval Militia, N. Y. 5th Batt.; Murray Harris (Corp.), O. E. R. C., Camp Upton; J. Nelson Hunter, British Royal Flying Corps; Raymond Zimber, U. S. A. Flying Corps, Mineola.

THE AMERICAN ASSOCIATION OF ENGINEERS has recently completed a branch organization in St. Paul, Minn., the occasion being celebrated by a banquet at which Mayor Irvin welcomed the association on behalf of the city, and invited the co-operation of engineers to assist in carrying out plans for a more beautiful city, and Prof. Wm. Brooke, of the University of Minnesota, complimented the association on its activities.

At a banquet recently held in Chicago, over 400 engineers were present and were given a vivid description of conditions in the warring countries by Captain Howard Scott. Dr. F. H. Newell, of the University of Illinois, discussed the activities of the association, speaking on the subject, "What Are We Here For?" Captain Garrison Babcock of the U. S. Signal Corps, past president of the association, was presented with a sabre by W. H. Finley, chief engineer of the Chicago & Northwestern Railway Co. and first vice-president of the association.

Among the guests of honor were Captain Robert W. Hunt, who spoke on "Our War," and emphasized the fact that it was an engineers' war; B. J. Arnold, W. H. Bailey of the Illinois Steel Co., A. S. Baldwin of the Illinois Central Railroad Co., E. W. Bemis, H. M. Byllesby, L. G. Curtis of the Baltimore & Ohio Railroad, J. D. Esposito of the Chicago Union Station Co., H. T. Douglas, Jr., of the Chicago & Alton Railroad, G. W. Hegel of the Chicago Junction Railway Co., B. E. Hill, W. W. Hodgson, Geo. W. Jackson, David Lofts, W. T. Martersteck of the Mark Mfg. Co., C. M. Mock of the Metropolitan W. S. Elevated Ry. Co., Arthur Montzheimer of the Elgin, Joliet and Eastern Ry. Co., and F. J. Postel.

IN CONNECTION WITH or in response to the call of the President for volunteers, the attention of all technical men; that is, men skilled in any line of science, mechanical, electrical, chemical, ordnance, explosives, mining, ship building, railroad, motors, metallurgy, building of aeroplanes, water supply or sanitation, etc., is especially invited to the need of the army for such young men—age 18 to 40—in sundry branches of technical troops concerning which write for literature to Major J. E. Bloom, U. S. A., 266 Market St., Newark, N. J.

Any technical "men who are exempt" or who from any cause cannot "volunteer," can yet efficiently cooperate, by forming Technical Patriotic Educational Guilds in their several industries or home neighborhoods, especially to look after the welfare of their men in the service, and to give them the opportunity of obtaining technical assistance, opinions and advice from home, in any war industry, from time to time.

Catalog Notes

AN INVESTIGATION of Pipe Corrosion is the title of Bulletin No. 30, issued by the A. M. Byers Co., of Pittsburgh, Pa.

The investigation was prompted by local agitation on the part of property owners who charged that chemicals were being used in the water filtration plants which destroyed the piping to such an extent that not even brass was immune. This subject was taken up by the Pittsburgh Board of Trade, and a report rendered which showed that no chemicals were used which could in any way be held responsible for the trouble; but the thought was expressed that the city should not be held responsible for the fact that much pipe of inferior quality had come into use in recent years.

In order to determine the life of pipe under varying conditions of service, Thomas F. Payne, a sanitary engineer, of Pittsburgh, was commissioned to make a house-to-house canvass of buildings, "with a view to ascertaining all the pertinent facts which might aid property owners in meeting the rust question in the most efficient manner." After several unsuccessful attempts to obtain accurate data from private residences and

other buildings, it appeared that apartment buildings offered the best field for investigation, and 125 such buildings, all in Pittsburgh, were investigated. A tabular statement gives the name and location of each apartment building investigated, the year of its erection, the length of time which both hot and cold water lines of brass, steel and wrought iron had been in service where rusted out, and their present condition where still in service.

The investigation showed the corrosion to be most severe in hot water mains (exposed basement piping) and the recommendation is therefore made that pipe one size larger than that used in regular practice be used. The larger size, having a greater thickness and larger bore, would not so easily rust through or become stopped up with rust.

The hot water risers, which are usually concealed, proved to have a much longer life than the basement mains. It is therefore a question whether the practice of specifying brass pipe for risers, and iron or steel for mains, might not better be reversed. Brass pipe in this investigation did not show up as well as might be expected, and many complaints were heard on that account.

Genuine wrought iron pipe, in 65 buildings, ranging in age from 8 to 20 yr., did not show a single failure when used for cold water supply, and in only one or two of these buildings did the wrought iron hot water risers require any repairs in the same period of time. Lead pipe, for hot water risers, seemed to have an average life of 18 yr., one complete failure being recorded after 14 yr. service.

It appeared from the investigation that the pipe lasted a little longer where an automatic water heater was used. This undoubtedly is due to the possibility of maintaining a lower temperature of the water than with a heater not having thermostatic control, for corrosion increases with the temperature, reaching its maximum between 140 and 170 deg. F. Temperatures from 115 to 130 deg. F. are therefore to be recommended wherever they will serve the purpose.

The rusting out of pipes is one of the prolific sources of trouble for the power plant engineer and he will welcome any research work on the subject. A copy of the complete report can be obtained from the A. M. Byers Co. by asking for Bulletin No. 30.

NEW FORMS have just been issued by Ingersoll-Rand Co., Chicago, as follows:

Form 859—4-page leaflet on I-R pocket oil flask.

Form 858—steam condensing plant leaflet.

Form 3118—32-page catalog on compressor and vacuum pumps for extraction of gasoline from natural gas.

Form 4302—20-page catalog on Sergeant rock drills.

THE GENERAL ELECTRIC CO. in Bulletin 45,505 describes the different types of regulators which have been designed for outdoor service. The results obtainable with induction voltage regulators are interestingly shown by diagrams on page 12 of the bulletin. These results not only give a uniform and steady voltage, but also reduce the cost of line construction and increase the revenue of the operating company.

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POSITION WANTED—By engineer with 11 years' experience in 325 hp. plant. Married. Steady and sober. Would like to get day work in Illinois. Address Box 497, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 11-15-2

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POSITION WANTED—By practical engineer of 15 years' experience. Am familiar with a.c. and d.c. generators and motors, also refrigerating machinery. Am 38 years old, married and strictly sober. Good references. E. W. Jones, Genl. Del., Metropolis, Ill. 11-15-2

POSITION WANTED—As chief engineer by middle-aged man, with 20 years' experience; famliiar with a.c. and d.c. generators and motors; also absorption refrigerating machinery and steam heating. Married and strictly sober. Present salary $1500. In present position 7 years. Desire change. Good reference. A. J. Marshall, Plainfield, Ind. 10-15-2

POSITION WANTED—As engineer or oiler in power or ice plant. Have had 15 years' experience. Fred J. Waite, 659 Douglas Ave., Aurora, Ill. 10-15-2

POSITION WANTED—By a licensed operating engineer with 5 years' experience. At present employed, but would like to make a change and locate in or near Philadelphia. Will consider position as operating or chief engineer at $150 per month. Can furnish best of references from present employer. Address Horace D. Ferrell, Box 501, Marcus Hook, Pa. 10-15-2

POSITION WANTED—Chief engineer desires change of location. Competent to handle large plant. Experienced with a.c. and d.c. machinery, irrigating machinery, ammonia compressors (practical ice-maker), gas engines and air compressors. Can install and do repairs. Not liable to conscription. Address Box 495, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-2

POSITION WANTED—As chief engineer. Am familiar with a.c. and d.c. generators and refrigerating and steam heating plants. I desire change. I can furnish good references and have been with present employer about 4 years. Age 35. Single. Address Box 715, Middleton, Conn. 12-1-1

POSITION WANTED—By married man. 36 yrs. old. Strictly sober and a hustler. Experienced with a.c. and d.c. generators and motors and line construction and steam engines of high and low speed. Present salary $1500 per year. Address Box 499, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 12-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

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FOR SALE—3 400-hp., Heine type, watertube boilers, with Murphy stokers, 2 yrs. service, 160-lb Hartford Insurance, $15 per hp.; 4 250-hp. Heine, 150-lb Hartford, $10 per h.p.; 2 150-hp. Babcock Wilcox, 160-lb. Hartford, $10 per hp.; 4 150-hp. return tubular, 125-lb. Hartford, $1,000 each. Power Machinery Exchange, Jersey City, N. J. tf.

AIR COMPRESSOR FOR SALE—10 and 20 steam, 12 and 12 air, all 10-inch stroke, Ingersoll-Sargent 450 feet free air, excellent order, $1,000 f.o.b. Federal Electric Welding Co., Baltimore, Md. 11-15-2

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FOR SALE—One 75 hp. Diesel engine with Kester electric belt driven generator, complete. The plan will be sold at a sacrifice. Address The Terre Haute Automobile Company, Terre Haute, Ind. 12-1-1

FOR SALE—Gas engine, 25 hp., run 11 months. A. Birch & Bros., Somerville, Mass. 12-1-3

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

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FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to gete some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes with back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

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